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NIVERSARY ISSUE

THE INDEPENDENT GUIDE TO PERSONAL COMPUTING MARCH 25, 1997 VOL. 16 NO. 6

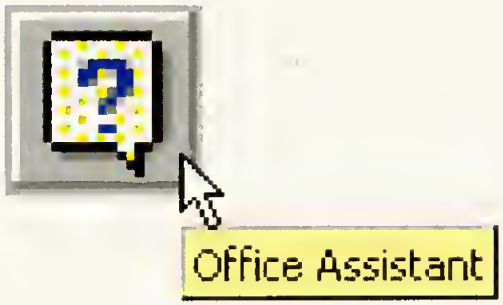
Ten Technologies That Will Change The Way the World Computes

Plus: Bill Gates and Gordon Moore Look Beyond the Year 2000

MAGAZINE

THE PC *of the* FUTURE





Microsoft Office 97/now/

/MBHomePage/ISShakespeare/Index.html



- What's New
- Getting Help
- Creating, Opening, and Saving Documents
- Typing, Navigating, and Selecting
- Editing and Sorting
- Checking Spelling and Grammar
- Formatting





Microsoft Office 97/now/

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spaceman.





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Between 1984 and 2001



In this era of constant change, we all tend to take the technology that we have for granted. The debates now raging in the computer industry—about the cost of ownership of PCs, the difficulties we face in configuring our computers, or even how big software has gotten—all seem important now, but they are really just blips in the development of PC technology.

These days, we tend to focus on the little differences among various strategies. We rarely pay attention to just how far we've come since the IBM PC was introduced a little more than 15 years ago. And even less often do we think about where all this technology is taking us.

Just consider what we now take for granted: 15 years ago, word processing was possible, but what you saw on your monitor was a screen font—completely different from what you printed. Printing boldfaced and underlined text was possible, but italics were unusual and awkward. Fonts? Well, you could always change the wheels on your daisy wheel printer. Now, without thinking twice, we expect WYSIWYG displays, dozens of fonts, and the ability to add graphics, print in color, and spell-check on the fly.

I remember logging on, 15 years ago, to The Source or to CompuServe—and later to some public BBSes—for what now seems like an awfully limited amount of material at slow speeds and high prices. Now, we have a World Wide Web that has more material than we can even think of tracking. People all over the world are joining in, and our biggest problem isn't finding data, it's data overload.

And the next 15 years promise even more. We expect to see faster processors, bigger hard disks, bigger and better displays, and lighter portables. Networking is gradually improving and that, too, will become easier and faster.

And all this is nothing compared with what will happen on the software front. People think software today is too hard, but it's easier to use than it was, and it will continue to get easier. People complain that programs are too big. But when push comes to shove, we all want more features, not fewer, and we get them.

Most important, software will be much smarter and much more customized to our individual choices. You won't notice any special dividing lines between software and the information on your local machine and what's on the Internet. Voice recognition will likely become mainstream, and intelligent agents will be as everyday as graphical user interfaces are today.

Let's be clear. Certainly, there's a dark side to all of this technology. Viruses, junk e-mail, online frauds, and out-and-out break-ins into computers will become more commonplace. New software makes it very easy to track what we are doing and where we are going with our computers, which might be convenient, but such tracking can also threaten our privacy. The technology that Big Brother needs is being introduced at a frightening pace—perhaps faster than our ability to understand how it should and should not be used.

But there is a bright side as well. We will have more information than ever before, and we'll be able to work with more people in more locations and in better ways. If we deploy it correctly, I believe that PC technology offers the promises that individuals can take more control of their individual lives, that different countries and cultures can better understand each other, and that every child can get a great education.

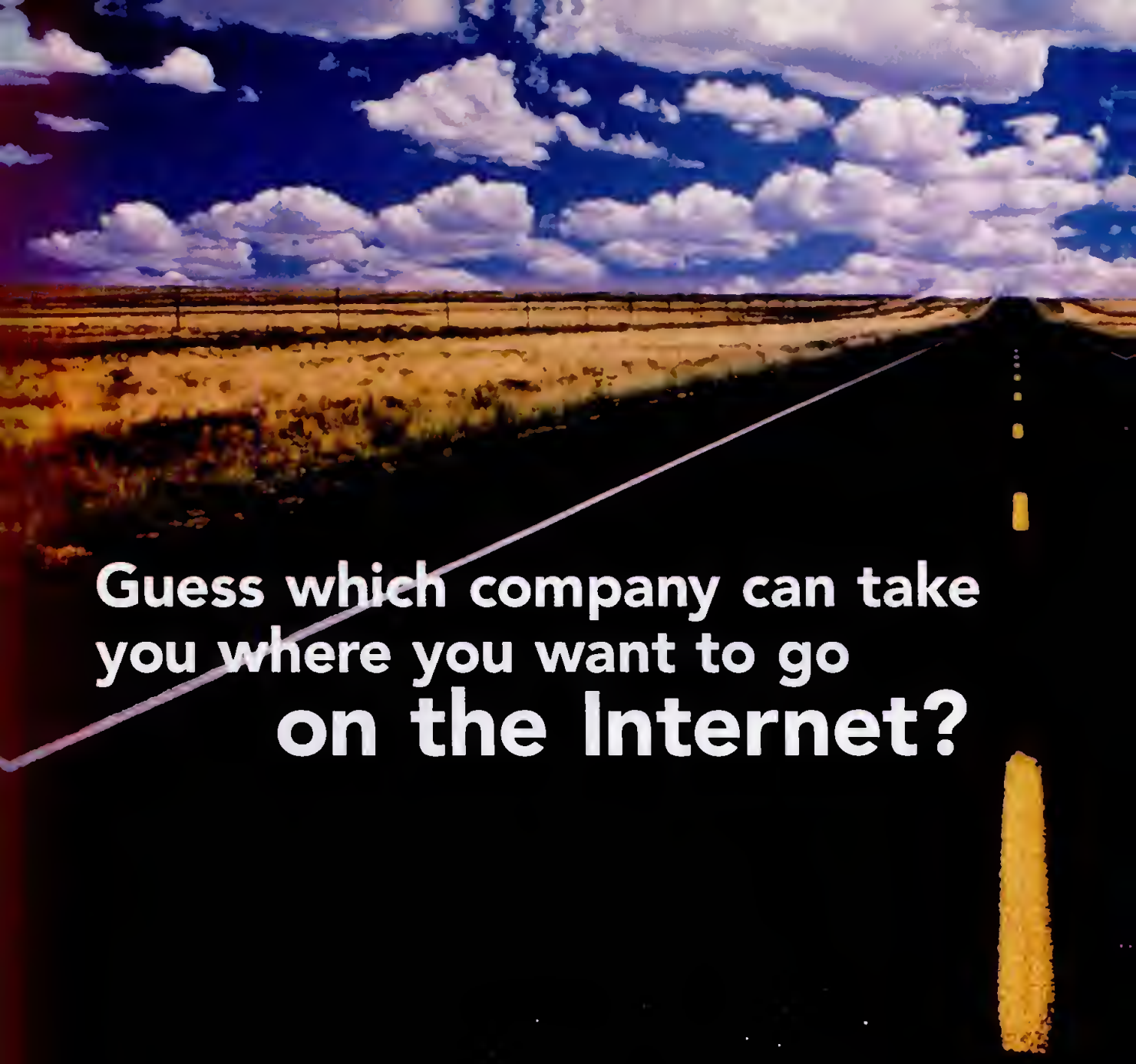
So here we stand, between the worries of George Orwell's 1984 and the wonders of Arthur C. Clarke's 2001. We are witnessing the development of the most exciting, fastest-changing technology in the history of the world. Over the next 15 years, we will choose how we use that technology. In turn, those choices will determine the kind of world we leave to our children.

Each of us will play a part in building this world. Let's look back at how far we've come and enjoy what we have now, but let's also look ahead and understand the possibilities of the future.



MICHAEL J. MILLER

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March 25, 1997
Volume 16
Number 6

SPECIAL ISSUE



Looking Back

BY MICHAEL J. MILLER The PC industry has moved ahead far faster than any other, but sometimes it's easier to appreciate how far you've come if you take the time to look at where you've been. We kick off our special anniversary issue by taking an in-depth look at the two-decade history of personal computing: the people, the machines, and the software that have changed our world. It's been a wild ride so far, and there's no sign that this pace is going to let up in the years ahead.....108

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Personal Pages

Join us at *www.pcmag.com* for more coverage of *PC Magazine*'s anniversary, and read extended versions of editor-in-chief Michael J. Miller's interviews with Microsoft CEO Bill Gates and Intel cofounder Gordon Moore. Also online: the new and improved InternetUser.

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BY BILL HOWARD

No matter how fast the technology of personal computing moves ahead, we always want more: more speed, faster delivery, greater ease of use, more functions and power. Fortunately, there continue to be significant advances in the key hardware, software, and networking technologies that drive the PC industry. We take a look at the current products—for the home and for business—that embody these developing technologies to give you an idea of where the course of personal computing will teke us through the year 2000 and beyond. Some technologies that are now key to the PC will fade over time. Others are only now beginning to show the promise of having a significant effect. But all of these products have the potential to reshape the way we live in the coming years. At the very least they'll make your computer run faster and let you hold more information in ever-smaller boxes 142

BILL GATES AND GORDON MOORE

Looking Beyond



For more than two decades, Bill Gates, chairman and CEO of Microsoft, and Gordon Moore, chairman emeritus of Intel, have been the driving forces behind the companies that are leading personal computing into the future. Both are technologists with a visionary bent. Here, in exclusive interviews with *PC Magazine*, they reflect on the industry's growth. More important, they look to the future and discuss personal computing in the next millennium.....229

THE FUTURE OF PROGRAMMING

The More Things Change

EDITED BY SHARON TERDEMAN

Programming continues to evolve rapidly. And although operating environments, languages, and programming methods are continuing to improve, other factors remain constant: the need for cross-platform compatibility, the search for new and better languages, and the struggle to produce user-friendly software. Here, to see what the future holds for the art of programming, we asked nine accomplished practitioners—Douglas Boling, Alan Cooper, James Gosling, John Lam, Gordon Letwin, Charles Petzold, Matt Pietrek, Jeff Prosise, and Neil J. Rubenking—to give us their views.....243



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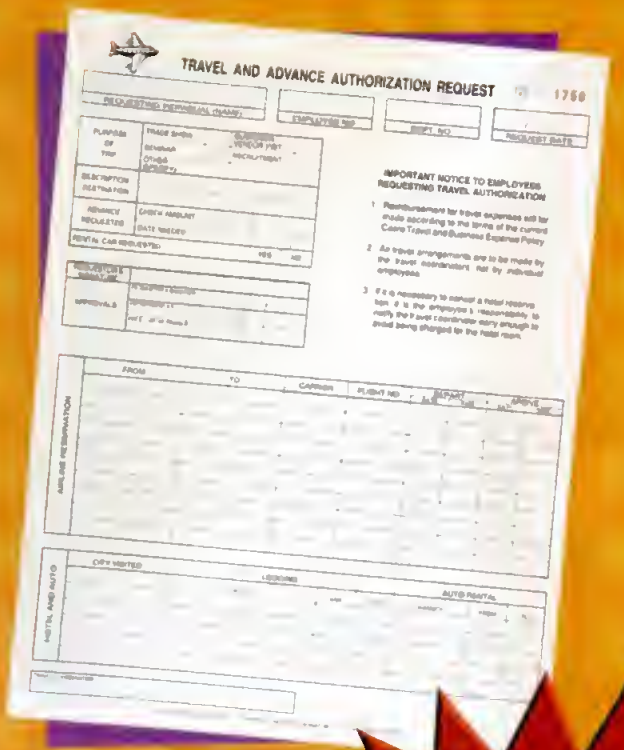
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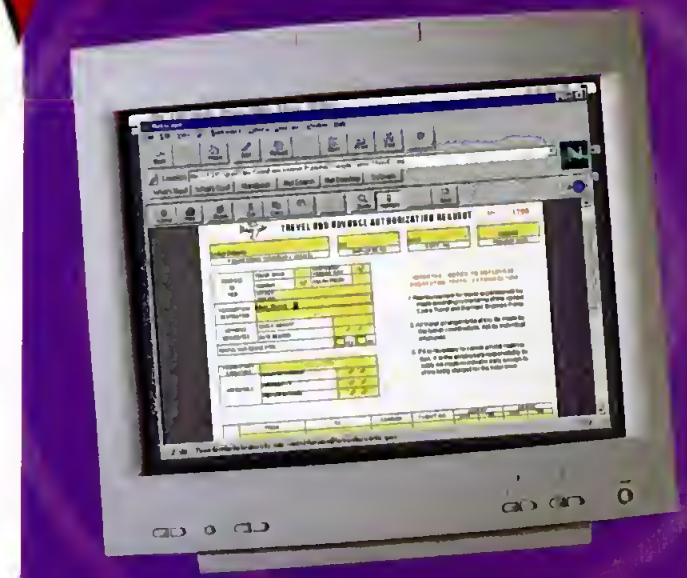
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Pipeline



Blast-Off!

The promise of worldwide wireless communication for mobile phones and pagers will become a reality when the long-awaited Iridium project—a worldwide wireless service for voice, data, fax, and paging—begins commercial operation next year. The launch of the first three satellites was scheduled for January but has been delayed until later this spring.

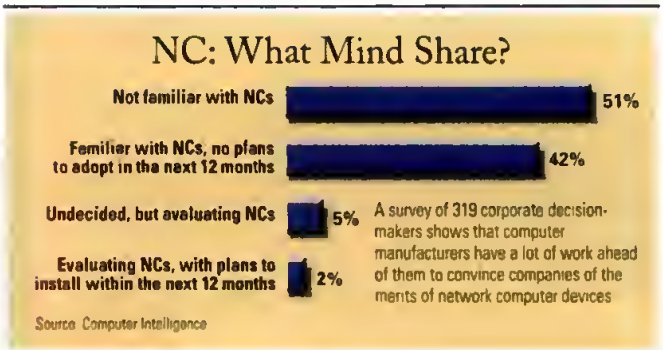


Iridium will track the location of subscribers' phones and allow communication between any two points in the world. The hand-held phones will connect to notebooks, personal digital assistants, and palmtops.

Iridium is owned by an international consortium of 17 investor organizations that have raised more then $2.6 billion to fund the project. Motorola is the primary contractor.

Since the system is narrowband, however, it's too slow for Web access. That's why Microsoft CEO Bill Gates and telecommunications pioneer Craig McCaw have big hopes for their Teledesic Network, a broadband mobile communications network. Teledesic, which is lagging behind Iridium's deployment schedule, relies on a constellation of hundreds of low Earth-orbit satellites. While Iridium is meant for short messaging, Teledesic is designed for "fiberlike" wireless telecommunications services, including interactive Internet access, voice, data, and videoconferencing.

London-based market research firm Ovum predicts that the number of subscribers who will use hand-held devices to access satellite-based voice and data services will skyrocket from 130,000 in 1998 to 8 million in 2002. Ovum expects the worldwide market to grow to $8.5 billion a year, with the Asia/Pacific region accounting for 40 percent of worldwide revenue, followed by the Americas with 27 percent, and Western Europe with 13 percent.



Cyber-Kermit

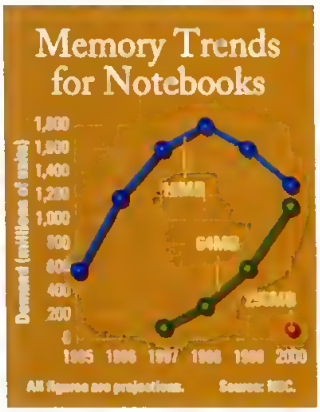
As if barnstorming holiday sales of Tickle Me Elmo dolls weren't enough exposure for the Muppets, The Microsoft Network has announced an exclusive relationship with Jim Henson Productions to develop interactive online programming on MSN featuring the Muppets. The three-year development plan calls for nine joint projects. Kermit the Frog has already been spotted hovering over a PC connected to MSN. The Muppets have been featured in several popular CD-ROM titles and will now function as Microsoft mascots online.



Next-Century Notebooks

The notebook of choice in the year 2000 will come stocked with a far bigger hard disk and far more memory than today's notebook, at little added cost, according to data compiled by NEC's Portable Systems Division. The company foresees the average 2.5-inch notebook hard disk hitting 4GB by 1998 and over 6GB (for 17-mm hard disks) by the year 2000.

RAM size is also on the upswing, according to NEC's forecasts. The greatest demand now is for 16MB of RAM, but by 1999 64MB will take its place, with the year 2000 seeing a flood of demand for 256MB of RAM in notebooks.



15 Years of Technology

WWW.PCMAG.COM Join us online as we celebrate *PC Magazine*'s fifteenth anniversary. Take an interactive tour of the technologies that excited us yesterday and the technologies that will excite us tomorrow, read the entire transcripts of editor-in-chief Michael J. Miller's interviews with Microsoft CEO Bill Gates and Intel cofounder Gordon Moore, and reminisce about your first PC in our discussion forum. How clunky was it? How much did you pay for it?

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Pipeline

Digital Cameras on a Budget

Priced at thousands of dollars a pop, high-quality digital cameras are too expensive for most amateur photographers. But now, developers are working on a clever new technology that could bring down the cost by the end of the year.

The cost of making CCDs—or charge-coupled devices, the photosensitive semiconductor chips that take the place of film in capturing images—is the major contributor to hefty prices. Manufacturers are turning to complementary metal-oxide semiconductor (CMOS) photodiodes, which are much easier and far less expensive to produce than CCDs.



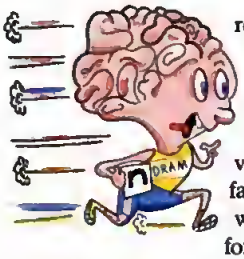
Digital workarounds: *Two exposures are better than one.*

Companies are concocting ingenious workarounds that make CMOS image sensors practical for lower-priced digital cameras. To increase light sensitivity, manufacturers are placing microlenses in front of each pixel, and to improve dynamic range, they are increasing the number of bits per color channel from 8 to 10.

One company, Sound Vision, has virtually eliminated "noise" from its camera's images. The SoundVision camera takes two pictures when you press the button. The first exposure captures an electronic image of the subject. Once the shutter closes, the camera takes a second exposure, recording noise as points of light in the dark register. The two images are instantly compared and the noise subtracted.

The 1,000- by 800-pixel camera will have an expected street price of around $350.

Memory Futures



PC designers have known for some time that existing memory architectures will soon be too slow to keep up with microprocessor speeds. Now that Intel has made a deal to license memory designs from Rambus, a developer of a super-high-speed memory interface technology, Intel has effectively anointed Rambus technology as the main memory architecture of the future.

Together, Intel and Rambus plan to design the next generation of Rambus dynamic memory, called nDRAM, which could reach 1.6 GBps by 1999.

Founded in 1990, Rambus has received praise for its 600-MBps DRAM interface, RDRAM, which is designed to run ten times as fast as conventional DRAM interfaces. But the company has won few actual contracts for the product.

Last year, Rambus had its first big break with the RISC-based game machine Nintendo 64, which posted excellent holiday sales. Rambus has also made great strides to minimize a weakness, high latency prior to the initial transfer of data.

According to industry newsletter *Microprocessor Report,* Intel's upcoming P7 processor (code-named Merced) will have a voracious appetite for memory. Intel expects Merced to be ready in about a year and nDRAM to be mainstream by 1999.

THIS ISSUE'S CONTRIBUTORS: *Andrew Boscardin, Daniel Grotta, Sally Wiener Grotta, Angela Hickman, Carol Levin, Melissa J. Perenson, Sebastian Rupley, Larry Seltzer, and Don Willmott.*

ILLUSTRATIONS BY M.E. COHEN (BOTTOM), AND CARY HENRIE (TOP)



Octo-Pro

The four-processor Pentium Pro system is already losing its cachet. Using new chip sets from Corollary and NCR, eight-processor Pentium Pro servers should be prevalent by midyear.

The Intel Pentium Pro offers built-in SMP (symmetric multiprocessing) capabilities, but it doesn't inherently support configurations of more than four processors. Thus, while so-called quad-P6 servers have been industry commonplaces, six- and eight-way Pentium Pro machines have been industry quandaries.

Corollary has broken the four-way Pentium Pro barrier with Profusion, an eight-chip architecture that interconnects two quad-processor buses without inserting a third bus in between. Profusion should debut this summer in systems from Hitachi and Samsung.

NCR's competing OctoScale architecture is scheduled to arrive in March via the company's WorldMark 4300 servers. OctoScale uses an additional bus to join two Intel quad–Pentium Pro boards.

Web Turf Wars

Hollywood studios—including Disney, Twentieth Century Fox, and Warner Bros.—are a few of the many groups that have been actively protecting the use of their copyrighted material in the online world.

Lately, Viacom, the parent company of Paramount Pictures, has been the most litigious. In a recent crackdown on unauthorized "Star Trek" Web sites, Viacom issued cease-and-desist letters to several dozen sites, noting that the posting of copyrighted material, such as images, sound and video clips, and even detailed episode summaries, is unacceptable and, presumably, grounds for Viacom to intervene. The resulting uproar among the online fan community prompted Paramount, which has an official "Star Trek" outpost on The Microsoft Network, to plan a response that would appear at *www.paramount.com.*



Cyberight: *"Star Trek"'s valuable online property.*

While Viacom is adamant about its case, middle-ground solutions can be found elsewhere. For example, in the case of the television series "Babylon 5," Warner Bros. has agreed not to prosecute fan sites, provided that the proper copyright information is appended to the material displayed therein.

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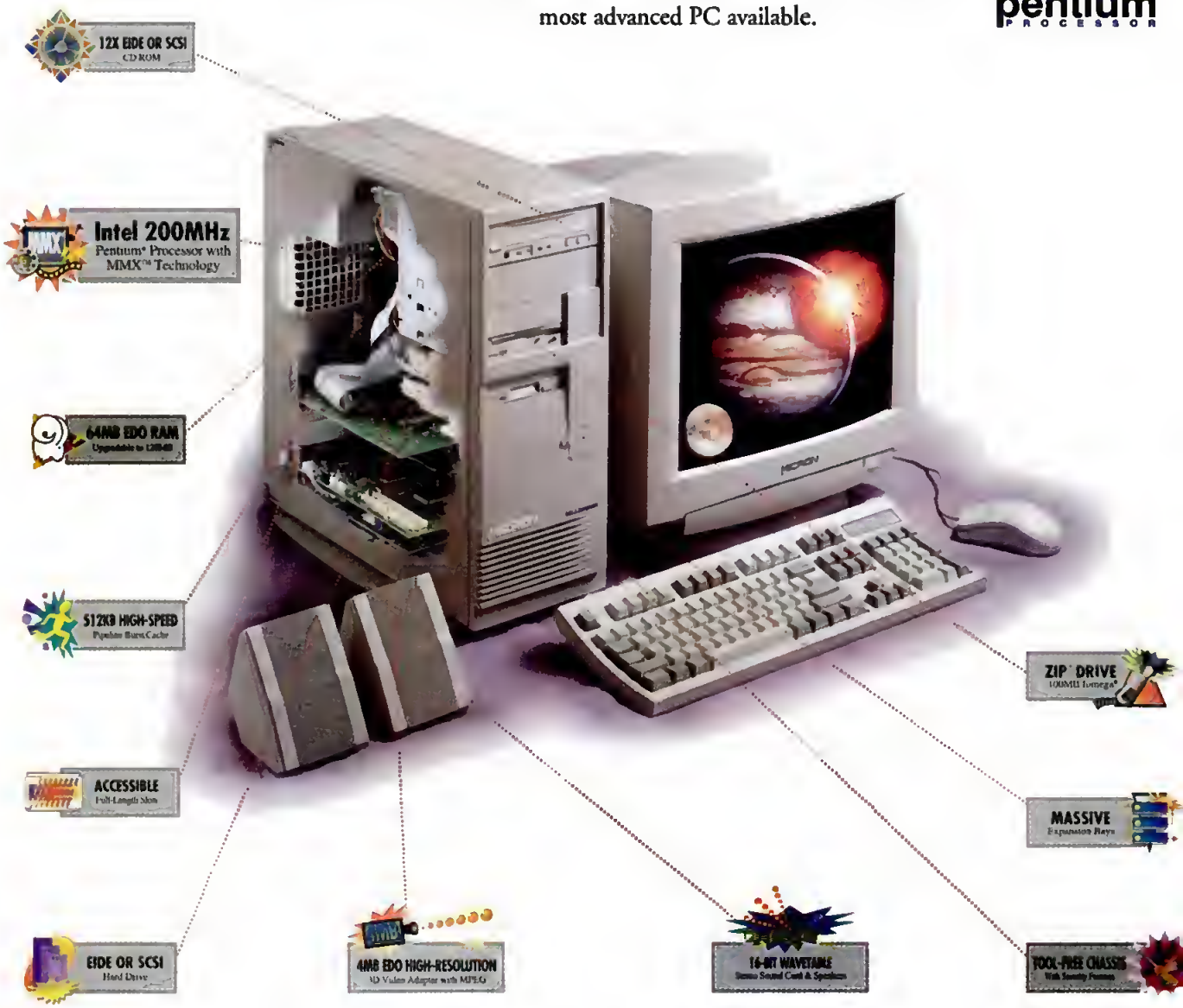
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Letters

DATA TO GO

I especially enjoyed the two pullout sections you included in the issue of December 3, 1996 ("The Netsearcher's Ultimate Cheat Sheet" and "PC Buyers' Guide"). Providing a great deal of information in a format that can be detached neatly without carving up the magazine is a nice touch. I put these in my desk reference binder for quick access. I would welcome several of them a month on various subjects.

TIM TARR
Clarion, Pennsylvania

Your cheat sheet is a great resource to keep handy on my desk. I only wish that the pullout was actually easy to remove from the magazine. When I then tried to pull it out, I started to tear the page. I finally used a pocketknife to cut the page.

ADAM GRAIS
via the Internet

Thank you for this wonderful guide. Although the December 3 issue came out after we took our ninth graders through a class on the Internet, I realized this sheet would have been a great educational asset.

SUSAN WILMES
via the Internet

Is there any chance that "The Netsearcher's Ultimate Cheat Sheet" would be posted on your Web site, or made downloadable, so we might bookmark it?

TOM DAVIS
via the Internet

"The Netsearcher's Ultimate Cheat Sheet" is available at our Web site at www.pcmag.com/iu/srchsite/_open.htm.*—Ed.*

PALMTOP TALK

In your otherwise informative article "Windows in Your Palm" (First Looks, January 7, 1997) on how Windows CE is going to rescue the "sleepy" and "moribund" PDA market, you ignore the U.S. Robotics Pilot. This thing has taken over the PDA market by storm. I see Pilots everywhere. On more than one occasion, I've walked into someone's office, seen a Pilot, taken mine from my pocket, and used it as an ice-breaker. I've even joined in spontaneous Pilot conversations while riding in elevators with total strangers.

JEFF GOODMAN
via the Internet

When will the makers of hand-held personal computers (HPCs) figure out the obvious? No matter how many great features they put into their palmtop PCs (such as word processors, spreadsheet, Web browsers, and so on), these features are not usable without an easier way to type.

Restricting users to entering data on a desktop PC, then downloading it to the HPC is great while you are in the office, but what about when you are at home or on the road? It seems to me that a simple solution would be an optional minikeyboard. With a real keyboard, you could easily create reports, type memos, letters, and notes, then connect the HPC to a phone line and fax, or e-mail the data.

STEVE PEMBERTON
Anaheim, California



The Netsearcher's Ultimate Cheat Sheet is a great resource.

In "Windows in Your Palm," the author states that "The first Windows CE palmtops will support IrDA infrared wireless printing," when in fact none of them do. The IrDA port is for PDA-to-PDA communications only.

DENNIS LEBMAN
via the Internet

GOING ALL-OUT

Thanks to your review of the Web search engines ("All-Out Search," December 3, 1996), I'm now able to find sites without spending hours searching for them. As usual, the article was to the point, extremely helpful, and not too technical.

RAFI KHOURI
via the Internet

I enjoyed your article about Web search sites. It was very informative, but there was at least one question it didn't answer: What is the motivation for search site developers to develop, maintain, and improve these sites? I don't see the economic incentive for them.

RICHARD W. GUNGEL
Downers Grove, Illinois

I am a proponent of fewer acronyms and abbreviations to complicate my life, rather than more. But as I prepare to teach a class in how to do research on the Internet, I find the need to constantly use the abbreviation *www* for the World Wide Web. For me, pronouncing this is a tongue twister. And when I say it fast, I get accused of slurring my speech. You know where that can lead you in corporate America. Therefore, I propose that we find a quicker and easier way to communicate the *www* portion of an Internet URL.

GREG PERLSTEIN
via the Internet

HOW COULD YOU?

I have been looking for a new video board for my machine and was glad to see the article "3-D For Free" in the *PC Magazine* issue of December 3, 1996. But how can you give the Editors' Choice to the Intergraph Reactor, the only board in the story to drop video frames? What good are 3-D graphics for an application if a simple movie file can't be played correctly?

KARL LODWICK
via the Internet

When we weighed all the factors, the Intergraph Reactor was the best all-around product, despite its low video score. Our tests reported a high number of dropped frames for this board, but when the video segments were played and subjectively analyzed, they were quite viewable. We believe that the high number of dropped frames was due to a known anomaly of the MCI interface in Windows 95; this problem has been fixed in the OEM Service Release 2. —Ed.

POINTING OUT PROBLEMS

When PointCast works, it is a neat product, allowing the user to snag information and news without having to track it down. ("Thirteenth Annual Technical Excellence Awards," December 17, 1996). However, PointCast has only wreaked havoc on my PC. When I first downloaded it, PointCast would not install. Then after my third download attempt, it did in fact install, but then crashed my PC while in the midst of downloading the first batch of information, taking my modem along with it.

MARY BETH GRANT
Urbana-Champaign, Illinois

HOME ISDN SURVIVORS

I have read all the articles on the difficulty and complexity of hooking up an ISDN line, in-


domino
.WORK THE WEB™

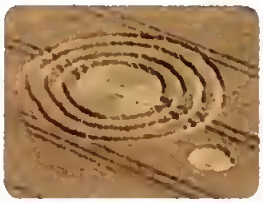
THE GREAT INVISIBLE GUIDING HAND OF CAPITALISM HAS JUST SMACKED THE INTERNET UPSIDE THE HEAD ► NOW WHAT?

NO MORE HYPE. No more jargon. No more paradigm shifts, okay? Everybody agrees the Web has the potential to be a monumental economic force. But from a capitalist point of view, the Internet has had about as much impact as the two-dollar bill. Why? For one thing, security is lousy. For another, building interactive websites that are linked to corporate databases (which is to say, useful information) takes forever. For still another, keeping those websites updated with timely information costs a fortune.

LOTUS DOMINO™ FIXES ALL THIS. Lotus Domino is web server software based on Lotus Notes® technology. It makes powerful, interactive websites easier to build. It lets people edit and manage the content on those websites using ordinary web browsers – which means the people who have the information people need can make it available simply by changing it themselves (this is the way the Web should work, but until now, it hasn't).

It not only lets you control who gets into your system but also what they can see, and what changes they can make. So you can let your customers see one thing, and your management another. You can let your finance department make changes to information your European sales offices can only see.

This makes Domino a powerful tool for creating solutions that are customized to the needs of your business. To let employees, managers, contractors and suppliers all work together over the Web. To help customers find the answers they need. To turn the Web from a digital warehouse for stale jokes and silly photographs into a tool that businesses can use to actually get things done. Log in. Find out. **www.lotus.com/worktheweb**



NO. Lotus Domino is not about circulating theories about the origins of crop circles. Or for putting more stupid stuff on the Web.

.NO



YES. Lotus Domino is for doing serious business on the Web. Transforming it into a powerful way to interact with customers and employees.

.YES

Lotus
Working Together®

For more information, call 1 800 828 7806, ext CB24. In Canada, call 1 800 60 LOTUS. © 1997 Lotus Development Corporation, 55 Cambridge Parkway, Cambridge, MA 02142. All rights reserved. Lotus, Lotus Notes and Working Together are registered trademarks and Domino and Work the Web are trademarks of Lotus Development Corp.

Letters

cluding the one in the *PC Magazine* issue of January 7, 1997 (Trends, "Way Fast Phone Lines"). So with great trepidation, I called GTE, and to my amazement, they had heard of ISDN, and we scheduled a date in about a week for installation. The day dawned, the serviceman showed up, and my cold sweats began. To my amazement, it was all set up and working in less than 20 minutes. He even gave me a few very helpful pointers on my modem hookup.

JOANNE WHITE
Redmond, Washington

I have to take issue with the views expressed in the article "Way Fast Phone Lines." I didn't have any problems with my Pacific Bell ISDN setup. Once the line was installed, I wired up an RJ-45 jack and mounted it behind my desk, plugged in the Sportster ISDN and modem, configured Windows NT's Remote Access Server, keyed in the details of the setup, and I was surfing the Internet at 128 kilobytes per second in less than an hour. I haven't had a single problem in two months. Nothing could be simpler.

DERICK QUA-GONZALEZ
West Hollywood, California

SCANNING THE CATEGORIES

After glancing at your article "The Fifty Best Products of 1996" (January 7, 1997), I was shocked to see that there wasn't a category for scanners. The task to come up with a range of categories to cover the interests of your readers must be daunting, but I think you dropped the ball by not including a scanner category.

JAMES E. MOORE
Greensboro, North Carolina

HOW TO CONTACT US

We welcome your comments and suggestions. Please send Letters to the Editor via

E-MAIL pcmag@zd.com

FAX 212-503-5799

MAIL Letters, *PC Magazine*, One Park Ave., New York, NY 10016-5802

COMPUSERVE To reach individual editors as listed on ZD Net, type GO PCMSTAFF.

All letters become the property of PC Magazine and are subject to editing. We regret that we cannot answer letters individually. To send submissions for PC Solutions, please see the sidebar "How to Contact Us" on the last page of that column.

CORRECTIONS AND AMPLIFICATIONS

In the Hardwara section of PC Solutions (Ask Our Advisors, "L2 Ceche Specifications," pege 264) in the December 17, 1996, issue, the correct system clock speed for the Intel Pentium 100 is 66 MHz, not the 60 MHz, which wes stated.

In tha list of people responsible for Frectel Design Expression, e finelist in the Graphics Software catagory of tha "Thirteanth Annual Technical Excellence Awerds" (December 17, 1996), a devaloper's name was misspallad. It should be "Sai-leung Siu," not "Sei-leung Su."

WHAT ABOUT THE REST OF US?

You have excellent columnists with fine reports on the latest happenings in the world of computers. But I use DOS and Windows 3.1, and your coverage of these two areas is limited to two or three pages of the "User-to-User" column. It is my understanding that many businesses continue to use Windows 3.1, and that there are millions of PC home users and hobbyists who do not use Windows 95. Your magazine is almost completely dedicated to that operating system, but we non–Windows 95 users still need help.

HAROLD SIMON
Ventura, California

I'd like to see a review of Linux running on a PC. This a real 32-bit multitasking/multiuser operating system. It doesn't have many of the flaws that DOS and Windows 95 have, and there are several programming tools and editors for this platform that won't cost $100 apiece. Admittedly, even a few years ago, this OS was only for hackers. But now I'd say it's ready for prime time.

LISA CHIANG
via the Internet

GETTING THE WORD OUT

I enjoyed reading Bill Machrone's article on Paul Newman's Hole in the Wall Gang ("Can You Help the Gang?", December 17, 1996). Being a self-taught computer professional, I have turned to *PC Magazine* countless times to inform and educate myself about technology. I guess I've learned quite a bit, because I now host a weekly radio show on a major AM station in Atlanta answering other people's technology-related questions. I get a number of calls from my listeners asking what they can do with their older computer equipment, as they move up to newer systems. Thanks to Machrone's article, I now have one more place to which I can guide people.

MIKE GENTRY
Atlanta, Georgia

AD PANDEMONIUM

I'm certainly not what you would call a prude, but I find Data Translation's ad in *PC Magazine* (January 7, 1997) for Broadway offensive in a magazine that is know to be read by all age groups.

ART GARLAND
via the Internet

If this were *Playboy* magazine, then this type of ad would be expected. But in a professional resource such as *PC Magazine*, it is completely inappropriate.

MARK JAMESON
via the Internet



Data Translation's ad for Broadway: Is it offensive?

The headline "Teach them how to screw" is blatantly offensive. I recognize that Data Translation is just trying to be clever, but this ad is gross.

JIM LOUGHLIN
Tulsa, Oklahoma

Although the editors do not control the advertising content of PC Magazine, *we decided to ask the advertiser, Data Translation, Marlboro, Massachussets, for a response to these letters. Company president Fred Molinari told us, in part: "I can't remember the last time someone took offense with (or even bothered to write in about) any ad in* PC Magazine. *Finding sexual innuendoes in words such as penetrating and screwdriver is indicative of a prudish mentality. What's next? White pages with AD-PG or AD-R warning parents of upcoming ads? Standing out among numerous products while educating potential customers are some of the main goals of advertising. Response to our ad has been overwhelming, and sales have increased substantially."—Ed.*

Forget all the promises about 100Mbps costing the same as 10Mbps.



It's already happened.

$135

CreditCard Ethernet 10/100 Upgradable

This 10Mbps Ethernet PC Card is upgradable to 100Mbps with the simple purchase of a new adapter cable.

$175

CreditCard Ethernet 10/100 Ready

Connects notebooks to either 10Mbps Ethernet or 100Mbps Fast Ethernet networks. Seamless 10Mbps and 100Mbps connectivity means you won't have to upgrade when you move to Fast Ethernet.

$199

CardBus Ethernet 10/100

This 32-bit CardBus adapter connects CardBus-equipped notebooks to 10Mbps and 100Mbps Ethernet networks with the fastest notebook-to-LAN connection available, closing the performance gap between notebooks and desktops.

Our proposition is simple: 100Mbps adapters for virtually the same price as 10Mbps adapters.

The CreditCard Ethernet 10/100-Ready prepares you for 100Mbps at nearly the price of a 10Mbps-only card. If Fast Ethernet isn't in your plans yet, the CreditCard Ethernet 10/100-Upgradable gives you great 10Mbps performance now, with 100Mbps when you're ready for it.

And for the fastest perfomance, the CardBus Ethernet 10/100's 32-bit, PCI-based design makes CardBus-equipped notebooks perform like desktop systems.

Whatever your situation, Xircom's award-winning Fast Ethernet family can give you the speed you need now, plus the speed you need for the future, at today's 10Mbps prices. Call us at 800-882-2953, or visit the Xircom Web site at www.xircom.com/100a. For multipack and volume pricing call your authorized Xircom reseller.

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The Mobile Networking Experts.

CIRCLE 273 ON READER SERVICE CARD

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SUDDENLY, EUROPEAN STANDARDS ARE A GORGEOUS NECESSITY.

As 17" becomes the standard for your multiple applications, and applications became more media-intensive, don't just settle for a bigger system. Acquire a better one. A media-ready Nokia 447X.

These are the first monitors in the world to achieve the new VESA standards for display clarity. Their 15.7" viewing area boasts an aperture grill of .25 mm, and refresh rates as lofty as 150 Hz for virtually frozen screens. They are even capable of the ultimate 1600 x 1200 resolution. In other words, these screens are not just larger, they are clearer—which translates directly to improved working conditions and user-sensitivity. You'll also be relieved to know these are the first monitors to be TCO'95 certified for greatly reduced screen





447Xi—High-resolution display, ideal for graphics-intensive applications



447Xav—Professional-caliber display with integrated speakers, sub-woofer, and microphone

*Models are continuously upgraded. Size of CRT measured diagonally. Actual viewing size is slightly less. Manufactured and designed in Finland in an ISO 9001 approved environment. © 1996 Nokia Display Products, Inc. Multigraph, Valuegraph, MicroEmission and FullScreen are trademarks of Nokia Display Products, Inc. E-Mail: bynokia@aol.com. Prices and specifications are subject to change without notice. The Energy Star emblem does not represent EPA endorsement of any product or service. All other trademarks are the sole property of their respective companies.

emissions. This reaffirms Nokia's leadership in the science it pioneered.

The media-ready series does more than extend Nokia's most award-winning model (7 industry "Bests" so far). It literally shouts innovation. Dual powered stereo speakers in front combine with a subwoofer in the swivel/tilt base to shape audio at the intimate volumes most suitable for working close to a monitor.



447Xavc—Adds to X series features with built-in color video camera

This gives you the kind of audio system that multimedia and communications applications require, without a nest of wires and speakers fighting for the precious real estate around your computer.



The audio capabilities of the media-ready series extend to the built-in microphone set in the top of the bezel (at ideal voice height). This feature completes the requisites for computer telephony. The 447Xavc model even houses the world's first inboard color video camera for video-capture and conferencing. Truly, the media-ready series enables the complete convergence of computing and communications.

Of course, each of these systems comes with full digital controls and on-screen menu-driven adjustments (which Nokia also pioneered). Yet their pricing is remarkably competitive. All of which makes the new 447X series a necessity for anyone making full use of their computer. After all, the best way to meet the standards is to work with the people who set them.

Visit us at **www.nokia-americas.com** or call **1.800.BY.NOKIA, Dept. N412.**

640 x 480	800 x 600	1024 x 768	1152 x 870	1280 x 1024	1600 x 1200
150 Hz	140 Hz	110 Hz	100 Hz	85 Hz	72 Hz

NOKIA

Trends



ILLUSTRATION BY GARY ZAMCHICK

Microsoft Family Room

The upcoming Entertainment 97 PC gathers hardware partners.

Microsoft is already entrenched in your office and your den, and now the company wants to control your family room as well. Microsoft, joined by a host of hardware vendors and entertainment companies, recently announced new components for Windows that will flesh out the so-called Entertainment 97 PC specification. The announcement may represent a big step toward convergence between consumer electronics and PCs.

The first Entertainment PCs, from Compaq, IBM, Micron, and Toshiba, will ship late this summer with a big push for the 1997 holiday season.

FAMILY ENTERTAINMENT HUB

Designed to put the full intelligence of a Pentium computer running Windows at the hub of a family entertainment center, the Entertainment 97 PC calls for a display of 27 inches or larger to provide TV broadcasts via one of three routes: a DirecTV digital satellite system (DSS), cable, or an ordinary analog connection. "The Internet is great for information, but it is not an entertainment medium," says Ed Hughuez, DirecTV's vice president for new media. "The DSS PC will focus on the full complement of entertainment services, from real-time tickers to enhanced television and everything in between."

Several hardware companies, including ATI Technologies and Tseng Laboratories, will provide graphics hardware for cable and analog connections for both new Entertainment PCs and existing PCs. "The Entertainment PC initiative will allow ATI, through its All-In-Wonder card, to provide the missing link that connects your current PC to traditional entertainment technology," explains David Jones, a group product manager at ATI. Since VGA displays are intrinsically digital, the PC can make the transition to digital TV simply with the addition of a video card.

Together with large-screen video, the specification for the Entertainment 97 PC puts into play a number of new technologies: DVD-ROM to show movies and play audio CDs; USB and FireWire ports to connect peripherals, such as camcorders and VCRs; wireless keyboards; and TV tuners.

An important part of the picture is Microsoft's Advanced Configuration and Power Interface (ACPI), which will enable the computer to stay in a low power state all the time, turn on instantly without a lengthy reboot, and continually receive data over the video channel.

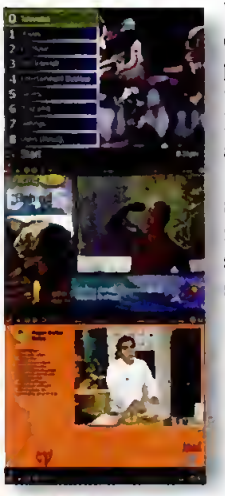
The Microsoft announcement details two new pieces of Windows specifically aimed at Entertainment 97 PCs and PCs with replacement video cards for TV capabilities. Broadcast Services for Windows (BSW) can collect video feeds of information, such as programming guides, stock quotes, Web pages, and encrypted information, while the PC is in low power mode, as well as cache the data to the hard disk.

At the user interface level are a set of applications that include an ActiveX control to display TV, an Electronic Programming Guide (EPG), and an Entertainment Center application.

PCs with standard analog connections will be able to receive data over the vertical blanking interval (VBI)—transmissions during the period when the TV gun is moving from the lower right of the screen to the upper left. VBI transfers at a rate of about 9,600 bits per second—about 100MB of data a day. DirecTV, which transmits a separate channel for data, allows up to 30-Mbps transmission speeds.

HTML-ENHANCED TV

Microsoft is also developing interfaces to TV viewing itself and is defining a new standard database for the EPG to which other software developers can add. With the intelligence of a Windows PC at the ready, the EPG can provide one-click setup of VCR programming and the control of child viewing based on ratings (part of the EPG database) without the need for a V-chip to restrict programs.



SURF YOUR TV: *Watch a sports show and jump to a Web site for stats.*

The video signal will be displayed in an ActiveX control normally running inside Microsoft Internet Explorer, a setup that lets you watch a cooking show, for instance, and surf to a recipe site on the Web. Among the content partners Microsoft has announced are Big Ticket, Ministry of Film, News Digital Sys, Rysher Entertainment, and the SciFi Channel.

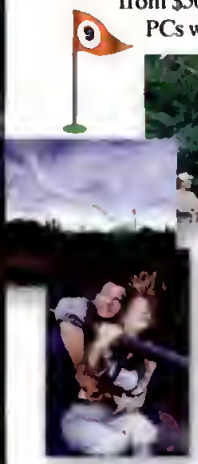
The convergence of computers and home entertainment has been predicted for some time now. Microsoft is placing a big bet that that time has come.—*Barry Simon*

Gadgets Galore

Electronics show highlights hot products.

Movies, music, and remote control. Americans' thirst for consumer electronics products reached a record high last year: According to the Consumer Electronics Manufacturers' Association, sales were up 4 percent over the previous year, and eager shoppers laid out $69.5 billion on electronic gadgets, including $29.1 billion on home information paraphernalia and $15 billion for video products.

The recent Winter Consumer Electronics Show highlighted some hot products that will hit the store shelves this year. Digital versatile disk (DVD) players top the list. Panasonic, Philips/Magnavox, Pioneer, RCA, Sony, Toshiba, Yamaha, and Zenith Electronics all expect to start shipping DVD players in March at prices ranging from $500 to $1,000. DVD players for PCs will be available on systems in the second half of this year and will cost about $500 more than a PC equipped with a CD-ROM player.



A FEW GOOD TITLES: Tin Cup *and* Twister *premiere on a DVD player near you.*

Film studios expect to master dozens of titles by the time the players ship and to deliver more than 100 titles in time for the 1997 holiday season. So far, only an eclectic collection that includes *Tin Cup* and *Twister* is available.

Manufacturers are also gearing up to produce electronic gadgets for CEBus, the decade-old technology that turns your PC into a remote-control center for the consumer appliances, security systems, and climate controls throughout your house. CEBus, which works from a PC, over an AC line, or via radio frequency, is now part of an umbrella standard know as Home Plug 'n' Play. Honeywell and Thomson Consumer Electronics promise working CEBus devices shortly.

Meanwhile, Yamaha is readying its prototype of a home music system that uses the 1EEE 1394 (FireWire) serial bus and is based on the mLAN audio and music protocol. The system is designed to digitize and transmit music (from up to 50 CDs at once) around the house over FireWire cables. A PC situated next to the main music center lets you click on a music source on-screen, then drag it to a room and adjust the volume.

—Bill Howard



INSIDE PC LABS

15 Years of PC Benchmark Tests

EVERY ONCE IN A WHILE, READERS ASK US, "Aren't the current computers fast enough?" Considering the over 10 million copies of ZD benchmark tests we've distributed, we at PC Magazine Labs would have to answer that computers will never be fast enough.

Each incremental improvement in performance allows new possibilities—speech recognition, video and animation, more-complex image manipulation and data analysis—and tools that make computers a more indispensable part of our lives.

Benchmark tests are at the heart of what we do at *PC Magazine*. And in celebration of our fifteenth anniversary, we'd like to provide a brief historical account of PC benchmark tests at PC Labs.



IN THE BEGINNING: *Early PC Labs staffers developed the benchmark-testing process.*

CLONE CLAIMS

Back in early 1984, it became apparent to then–editor-in-chief Bill Machrone (currently vice president of technology for Ziff-Davis) that our readers needed an objective way to explore and validate the price/performance gains PC clone makers were claiming over IBM's mainstream PC and XT offerings. Using *Car and Driver* magazine as a model, Bill and technical assistant Michael O'Conc devised a computer equivalent to the 0- to 60-mph acceleration test, and our first set of PC performance and compatibility tests was born. The tests debuted in our April 3, 1984, issue, "The IBM Compatible Universe."

For the first performance test, we measured the time a PC needed to write 20 1K blocks to disk and then read them back, to calculate all the prime numbers between 1 and 50, and to load WordStar. Compatibility tests included running the official IBM PC Diagnostics.

OFFICIAL STATUS

By mid-1985, the benchmark tests were updated and officially named the PC Magazine Labs Laboratory Benchmark Series. These tests included 13 modules, of which 5 were used to benchmark-test PCs. The PC modules included disk read/write tests of both sequential and random data, prime-number determination, assemblies, compiles, and links.

In 1986, PC Labs overhauled the benchmark tests to include floating-point operations, 8088 and 286 instruction mixes, and RAM measurements. We revised the benchmark tests yet again in 1987 to include 386 instruction mixes and BIOS disk-seek and DOS disk-access tests. Release 4.0 of the benchmark tests, unveiled in 1988, added low-level graphics tests, with direct-to-screen memory writes, and video BIOS tests, with and without scrolling. In 1989, we added DOS file-access tests as well as expanded and extended memory tests. The first release of WinBench occurred in 1990.

ENTER ZDBOP

Release 6.0 shipped in October 1991 with an improved user interface and an assortment of database features that allowed the comparison of multiple graphical systems. We included a 486 instruction mix and a second release of WinBench on the same disk.

In 1992, the Ziff-Davis Benchmark Operation (ZDBOp) took over the design and execution of our tests and embarked on a considerable overhaul of the CPU instruction mixes, using volumes of instruction profiling data gathered from AMD, Cyrix, and Intel. ZDBOp released the first version of the benchmark test suite ZD Winstone at the Fall Comdex trade show in 1993, then substantially reworked it; CPU tests were also improved yet again. Since then, our benchmark tests have taken on a professional shine and continue to improve every year. The benchmark test challenge is enormous, but we plan to be here to help you through the next 15 years.—*Nick Stam*

PHOTOGRAPHY COURTESY OF WARNER BROS (LEFT), THOM O'CONNOR (TOP), AND *PC MAGAZINE* ARCHIVES (RIGHT)

What's NeXT?

CEO Amelio outlines Apple's upcoming OS.

Apple CEO Gil Amelio's recent defense of his company's industry position has been undermined by larger-than-expected financial losses, but Apple's acquisition of NeXT Software is raising interesting possibilities. Apple's brand-new, high-end operating system, Rhapsody, is on its way.

The company's fortunes depend heavily on creating Internet- and intranet-smart operating systems and applications. Both Eric Schmidt of Sun Microsystems and Jim Barksdale of Netscape Communications have stressed the rapidly growing revenue potential of Internet products as bright spots for Apple. Barksdale says Apple's opportunities could arise from the growth of Internet-centric products, which, according to Forrester Research analysts, will constitute a $200 billion industry by the year 2000. Adds Schmidt, "Apple is a company that gets it about networks and the network opportunity. The Internet and Java are too big for one player or only a few players to dominate."

Many analysts have said that $400 million for NeXT Software was too high a price to pay, but Amelio maintains he bought NeXT's operating system technology because it is the "ideal complement to Apple's software." Amelio says that the next-generation Apple operating system, based on NeXT, will be optimized to run on PowerMac hardware and will be customized for Sun Microsystems' Java.



Amelio stresses that Apple's new operating system will emphasize NeXT technology rather than just employ bits and pieces along with Apple's Copland technology. The upcoming operating system, called Rhapsody, will be based largely on the NeXTStep OS, which is built on the Unix Mach kernel. The new OS will have an interface true to existing Macintosh standards, although the first release won't run existing Macintosh applications. A 1998 release will run existing Macintosh applications through software emulation.

It will also incorporate support for QuickTime Media Layer, Meta Content Format, and TCP/IP. Like NeXTStep, Rhapsody will emphasize crash protection and preemptive multitasking, helping Rhapsody compete with Microsoft Windows NT. Amelio has made little mention of how Rhapsody would approach multiprocessing, a key issue if this OS is to compete with Windows NT.

Contrary to many reports predicting a 1997 arrival of the hybrid NeXT/Apple OS, Amelio has said that only the developer's version of Rhapsody will show up—and that not until late in the year—and that consumers will not see the OS arrive until the first quarter of 1998. Amelio also says Apple will continue to upgrade its System 7 operating system technology even after Rhapsody arrives.—*Sebastian Rupley*

JAKE KIRCHNER

When No News Is Good News



PC makers sold 10 million more machines in 1996 than they did in 1995. According to one count, they shipped almost 71 million machines total worldwide, a year-to-year increase of almost 18 percent. This significant growth was on top of even greater percentage gains the year before that. These numbers would lead most people to believe that there's no end in sight for the decades-long expansion of the personal computing industry.

And yet for some reason, this amazing market vitality has been greeted with great concern by the financial geniuses on Wall Street and the sharp-eyed pundits of the general business press. Of course, these are the people for whom there is no such thing as good news and to whom the glass is always half-empty.

These naysayers rightly note that the fourth quarter of 1996 was slower than predicted, as holiday sales at computer stores failed to meet the unrealistic forecasts of overly hopeful retailers. And it's true that Apple is selling fewer machines as it struggles to regain its footing. But if retail customers—perhaps awaiting the new MMX Pentium machines introduced in early January—failed to turn out in record numbers, the business-oriented PC market has been skyrocketing.

According to year-end numbers from market research firm Dataquest (the source of the 71-million-units-shipped number), the leading sellers to the business PC market saw significant sales gains in 1996. Compaq, the world leader, sold more than 7.1 million machines last year, a 1-million-unit (or 18.5 percent) gain over 1995. Number two, IBM, enjoyed a 27.9 percent increase, shipping 6.1 million PCs to exceed the 4.7 million it sold in 1995. Hewlett-Packard's numbers were even more impressive: a 51.8 percent increase in sales, from 1.9 million machines in 1995 to 2.9 million in 1996. And domestically, Dell was on a huge run, shipping 71 percent more PCs in the U.S. last year than the year before—1.8 million machines versus 1 million.

Numbers from International Data Corp. (on a worldwide basis) and from Computer Intelligence (for the U.S. market) closely matched the Dataquest numbers. And in the midst of these hardware hallelujahs, Intel and Microsoft, the other industry bellwethers, reported huge revenues and profits. So we at *PC Magazine* found it a little disconcerting to be inundated with phone calls throughout January and February from stock analysts and business reporters wanting our take on why the PC industry had "stumbled." Would IBM's stock-price drop—evidently due to disappointing mainframe sales—affect the high-flying stocks of Compaq, Intel, Microsoft, and other PC industry leaders? they asked.

Our response: "Stay calm. Look at the big picture. The PC business—hardware and software—is doing just fine."

One of the benefits of having been in the PC industry full-time for quite a while is that we get used to taking the long view of things. As we were reminded in preparing our fifteenth-anniversary material (which you'll find elsewhere in this issue), the personal computing business has come a very long way in a very short time. 15 years ago we were already well into the PC age, but worldwide sales were less than 1 million machines a year. Today, that figure's pushing almost 100 million machines every year.

If there's bad news in that record, I can't find it.

ILLUSTRATION BY FRANCISCO CACERES. PHOTOGRAPH BY SHONNA VALESKA

Microsoft BackOffice—

a diverse selection of servers united by a single «raison d'être.»

(That's French for "integrated ... philosophy.")



The new Microsoft® BackOffice™ is a different approach to server software solutions. Not just a shrink-wrapped product, BackOffice is a big, wide family of servers, each designed with the Internet in mind, all designed to work together. This means you can choose from the broad range of BackOffice server software to assemble the best solution for your business—one that augments what you already use, extends your organization to the Internet and remains open to the future. And because all the BackOffice products are based on Microsoft Windows NT® Server, you know they will work independently and integrate flawlessly. So what Microsoft BackOffice gives you is more than a bunch of server software products—it's a comprehensive strategy for implementing easy-to-use, easy-to-manage server solutions across your entire organization. Or, as the French would say, "Savoir-faire is everywhere."

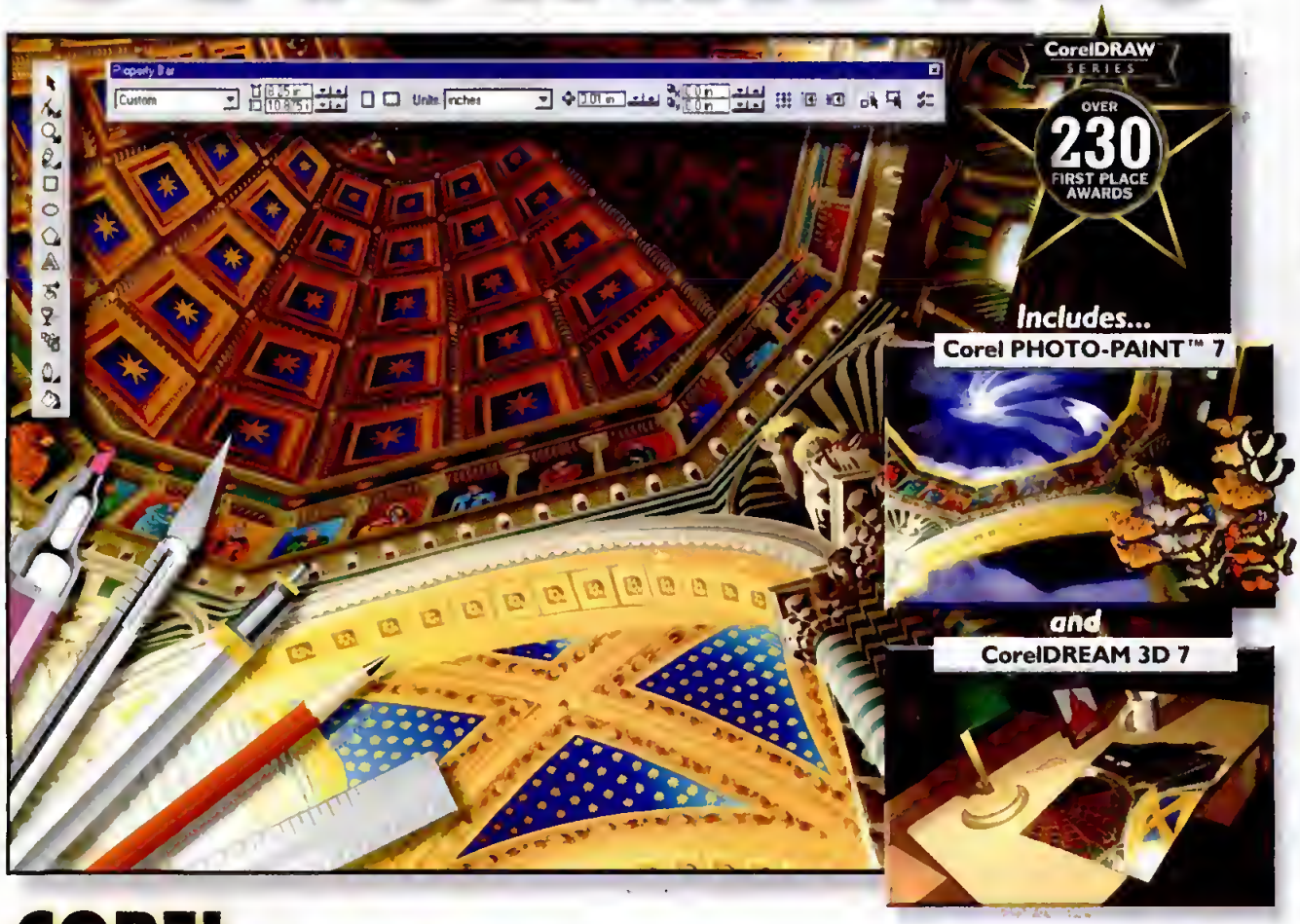
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DESKTOP PCs

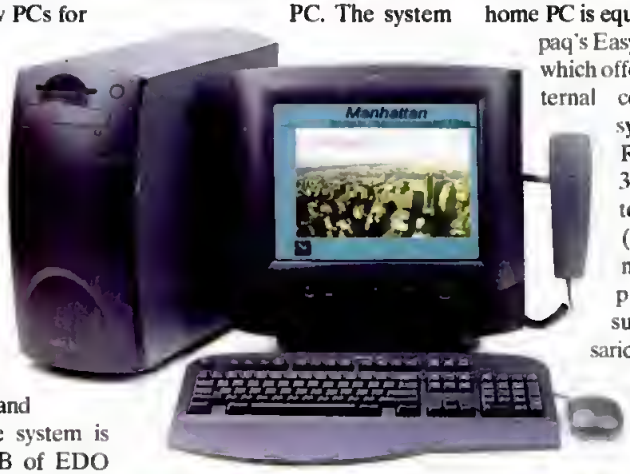
PCs for the Proletariat

A new wave of budget-priced PCs may hasten the machines' penetration of the home. Several leading manufacturers, including AST Computer and Packard Bell Electronics, are selling new consumer PCs for about $1,000, while other vendors, including Acer America Corp. and Compaq Corp., have new PCs for less than $1,500.

Packard Bell Electronics (800-733-5858, *www.packardbell.com*) is offering the **Packard Bell C115**, a 120-MHz Pentium PC that will sell for $1,000. The industry's leading home-PC seller is billing the C115 as a machine for family computing and Internet access. The system is equipped with 16MB of EDO RAM, a 1.2GB hard disk, an 8X CD-ROM drive, and a 33.6-Kbps fax modem with voice mail and a full-duplex speakerphone. The $1,000 price includes a 14-inch monitor, 16-bit SRS 3-D Amphitheater Stereo sound, and a 64-bit graphics accelerator with 1MB of graphics memory (upgradable to 2MB) and MPEG 1 full-motion video playback. (A less expensive version of the system will be offered without the monitor.) Packard Bell's Fast Media technology allows for one-touch access to the Internet as well as to the machine's various communications features.

Meanwhile, AST Electronics (800-876-4278, *www.ast.com*) is selling a sub-$1,000 multimedia PC exclusively through the world's largest retailer, Wal-Mart. The **AST Advantage! Adventure 575** features a 133-MHz 486-class processor, 8MB of memory, a 630MB hard disk, an 8X CD-ROM drive, a 14.4-Kbps fax modem, and a 14.4-inch color monitor. The system's two stereo speakers are backed by Sound Blaster–compatible audio. The Advantage! Adventure 575 comes with a full one-year warranty.

Edging just above the $1,000 watermark is Acer (800-558-2237, *www.acer.com*), which offers the $1,200 **Aspire 2011** home PC. The system features Acer's charcoal-gray chassis, has a 133-MHz Pentium processor, 16MB of RAM, a 2GB hard disk, and an 8X CD-ROM drive. This attractive price does not include a monitor (Acer's 14-inch monitor is $300), but it does cover a 33.6-Kbps fax modem with a speakerphone, a 16-bit audio card with 3-D sound, and 256K of pipelined-burst L2 cache. Acer also includes software MPEG 1 support and a one-year parts-and-labor warranty.



CHEAP THRILLS: *The Acer Aspire 2011.*

For only $100 more than you pay for Acer's system, Compaq Computer Corp. (800-345-1518, *www.compaq.com*) is now selling a 150-MHz Pentium-powered **Presario 4160** with 24MB of memory and a 2.1GB hard disk. This $1,300 home PC is equipped with Compaq's Easy Access Buttons, which offer convenient, external controls for the system's 8X CD-ROM drive and its 33.6-Kbps DVSD telephony modem (featuring voice mail, speakerphone, and fax support). The Presario also includes a 32-bit PCI graphics card with 1MB of EDO RAM, two JBL Pro stereo speakers that can attach to the side of any standard Compaq monitor, and integrated Compaq Video Phone receive software. Although a monitor is not included (Compaq sells a 14-inch monitor for $350), the price does include a one-year parts-and-labor warranty with 90 days of on-site service.—*Cade Metz*

UPGRADES

MMX Your Old PC

After unveiling the Pentium Processor with MMX Technology in January, Intel Corp. (800-548-4725, *www.intel.com*) is offering an OverDrive Processor version of the chip for upgrading Pentium desktops.

With a built-in voltage regulator, an integrated fan/heatsink, preconfigured bus-to-core clock speed ratios, and compatible pinout, the **Pentium OverDrive Processor with MMX Technology** allows users to easily replace their outdated processors and upgrade to 150- or 166-MHz MMX processing. MMX—a set of 57 new instructions designed to enrich and accelerate PC multimedia—is being incorporated into all future Intel processors. For the speed demon, a 200-MHz MMX OverDrive chip should arrive in the second half of this year.—*CM*



DESKTOP PCs

Zip it Up



READY BACKUP: *The Micron Millennia comes with an Iomega Zip drive.*

Convenient backup—long an afterthought—is quickly becoming a major feature with corporate PCs. At the start of the year, Compaq Computer Corp., Dell Computer Corp., Gateway 2000, and Micron Electronics announced either standard or optional internal Iomega Zip drives for their high-end PC lines. They join the ranks of NEC and Hewlett-Packard Co, both of which have offered drives as options. These drives allow you to store and organize significant digital information on removable 100MB hard disks at a relatively low cost.

According to Micron (800-388-6334, *www.mei.micron.com*), the **Micron Millennia MXE** is the first direct-channel system to include an Iomega Zip drive as standard equipment. There are six base configurations of this system—all built around 160- and 200-Mhz Pentiums with MMX Technology. Prices start at $1,999 with a 15-inch monitor.

A nondirect vendor, Compaq (800-345-1518, *www.compaq.com*) has also incorporated the Zip drive as standard on the forthcoming **Prasario 4784** minitower. Prices start at $2,400.

Dell (800-388-8542, *www.dell.com*) is providing the Iomega Zip drive as an option on its new **Dimension XPS M166s** and **M200s**, which also use the new MMX Pentium CPU. Prices start at $2,199; the Zip drive is a $139 option.

Similarly, direct sales vendor Gateway 2000 (800-846-2000, *www.gw2k.com*) is offering an internal Zip drive option with its entire desktop line of PCs. These drives will ship with Iomega Zip tools software. —*CM*

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– PC WORLD, December, 1996 –

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LANGUAGES

The Power of Language

Whether you're looking to brush up your high-school Spanish for fun or get a crash course in Chinese because you're being transferred to Guangzhou, there's a language package available to suit your needs.

Transparent Language (800-752-1767, *www.transparent.com*) adds to its stable of language offerings through its recent purchase of BayWare, which manufactured Power Japanese and Power Spanish.



WHEN IN ROME: *Language packages from IMSI (left), Syracuse (above), and Transparent (top).*

The next in the line of Power languages is the $99 **Power Chinese**. Chinese is considered one of the most difficult languages to learn, but Power Chinese tries to make the language more accessible to English speakers. The software compares and contrasts phrases in Mandarin Chinese with their English counterparts; in this way, you start building a base foundation of words and expressions.

The course features over 600 Chinese characters, 800 phrases, and 1,200 sentences; there are also over 2,500 audio clips recorded by native speakers and numerous videos depicting real-life situations. Equipped with a friendly and intuitive interface, the multimedia-intensive program features many interactive drills, including tutorials in pronunciation, the use of four different vocal tones in spoken Chinese, and the main difficulties of Chinese syntax and grammar.

Meanwhile, Transparent has upgraded its $29.95 **Language! Now** series of multimedia learning products. Available in eight languages (French, German, Italian, Latin, Portuguese, Russian, Spanish, and English for Spanish speakers), these packages provide ample instruction for building basic conversation and reading skills. New features include video tours, a reference resource of common words and phrases, and an introductory guide to the language.

Also from Transparent is **WordAce!**, a bilingual translation package that takes words from French, German, Italian, and Spanish and translates them into English—and vice versa. The $29 WordAce! has over 100,000 definitions and translations, as well as 500,000 verb conjugations, native-speaker pronunciations of over 40,000 words, and learning games.

There are also $29 bilingual packages, without sound, for such languages as Danish, Dutch, Finnish, Portuguese, Norwegian, and Swedish.

A similar product is IMSI's $29.95 **Easy Language: 17 Language Edition** (800-833-4674, *www.imisoft.com*), which provides vocabulary and pronunciation lessons for everyday words and phrases. This two-CD-ROM set includes 2,000 key words and 250 phrases in American and British English, French, German, and Spanish (Castilian and South American). There are also 1,000 key words in Arabic, Chinese, Danish, Dutch, Greek, Hebrew, Indonesian, Italian, Japanese, Korean, Portuguese, and Russian. A translator lets you choose either English, French, Italian, German, or Spanish as the source language.



From Syracuse Language Systems (800-797-5264, *www.syrlang.com*) comes the **Let's Talk** series of language tutorials. Priced at $44.95 apiece and available in French, German, Italian, and Spanish, the Let's Talk line builds vocabulary and conversational skills for those at the beginner or intermediate level. For speakers of Chinese, French, German, Italian, Japanese, Korean, Portuguese, and Spanish, there's an English tutorial. You can learn over 2,200 words with the help of a speech-recognition module and compare your pronunciation with that of native speakers.

If you're looking for a more classroom-oriented environment, try attending Syracuse's **Language Connect University**. A $475 12-lesson interactive course is comparable to a four-credit college course in Spanish 1, where participants receive online instruction, exams, and evaluations. The weekly lessons require about six hours of study per week.—*Melissa J. Perenson*

UTILITIES

Master Utilities for Windows NT

Ready to get the most out of Microsoft Windows NT 4.0? Symantec Corp.'s $120 **Norton Utilities for Windows NT 4.0** will help you do just that (800-441-7234, *www.symantec.com*). This indispensable collection of utilities was designed especially for Windows NT 4.0 and helps you head off problems at the pass. At the same time, Norton Utilities helps improve your system's performance.

By constantly monitoring your Windows NT workstation or server, the comprehensive System Doctor can predict potential problem arees and automatically apply a fix before you experiance a system crash or data loss. If a physical hard disk failure is imminent, the Self-Monitoring and Reporting Technology sensor gives you anough warning so you can back up your critical data.

Internet users will appreciate System Doctor's Internet Speedometers. Thay monitor both your connection and the site you're visiting to determine the optimal time to surf the Web and the turnaround time for a particular site.

The Norton Disk Doctor module detects and corrects most hard disk problems and is capable of performing diagnostic and repair operations on both FAT16 and NTFS drives. Meanwhile, Norton Speed Disk takes care of defragmenting your system, and Norton System Information conveniently provides component and usage statistics for a given workstation. The Norton Protection/UnErase feature lets you recover files that have been accidentally deletad.—*MJP*

MONITORS

So Many Monitors...

Although 17-inch monitors have become more popular at the expense of 15-inch models, manufacturers continue to flood the market with both sizes. And with new vendors entering the fray, the latest models from such familiar names as MAG InnoVision, NEC Technologies, NSA/Hitachi, and ViewSonic are sharing the shelves with offerings from such newcomers as Shamrock and ShinHo.

From NEC (800-632-4636, *www.nec.com*) come two models featuring the company's unique CromaClear CRT, which uses a new 0.25-mm mask design that enhances image clarity. The $400, 15-inch **MultiSync XV15+** delivers 1,024-by-768 resolution at 85-Hz refresh, and the $800, 17-inch **MultiSync XV17+** has a 1,280-by-1,024 maximum resolution at 75 Hz.



Left to right NEC, ViewSonic, and ShinHo.

MAG InnoVision (800-827-3998, *www.maginnovision.com*) hits the scene with its ultra-affordable V² Series. The $340, 15-inch **510V2** has a 0.28-mm tube with 800-by-600 resolution at 80-Hz refresh. The $550, 17-inch **710V2** uses a 0.28-mm tube and delivers 1,024-by-768 resolution at 80 Hz.

NSA/Hitachi (800-441-4832, *www.nsa-hitachi.com*) will soon ship a new 17-inch offering, the $700 **SuperScan CM630U**. Good for graphics users and corporate desktops, the high-refresh unit will use 0.26-mm dot pitch and deliver 1,280-by-1,024 resolution at 80-Hz refresh; the monitor can also handle 1,600-by-1,200 resolution, though only at 68 Hz.

From ViewSonic Corp. (800-888-8583, *www.viewsonic.com*) come two 15-inch contenders, the $350 **E655** and the $350, multimedia-enabled **Optiquest VA656**. Both deliver 1,024-by-768 resolution at a refresh rate of 80 Hz. Optiquest includes integrated speakers and microphone.

New to ViewSonic's 17-inch lineup is the $950 **PT775 SonicTron**. Targeted at graphics professionals, this aperture grille model has a fine 0.25-mm dot pitch and delivers 1,600-by-1,200 resolution at 77 Hz (and 1,280-by-1,024 at 89 Hz). The more affordable $600, 17-inch **Optiquest V773** is geared toward the SOHO and general business user. This 0.26-mm dot-pitch monitor can deliver 1,024-by-768 resolution at a refresh rate of 80 Hz.

From its SuperView series of midrange monitors, TeleVideo (408-954-8333) offers both the 15-inch **SV100** ($389 list), which delivers 1,024-by-768 resolution at 85 Hz and 0.28-mm dot pitch, and the 17-inch **SV200** ($665 list), which has the same resolution as the SV100 at 86 Hz and a finer 0.27-mm dot pitch. For higher-end graphics and CAD needs, the SuperView Pro series includes the 17-inch **SVP250** ($999 list), an aperture grille monitor that features Shadow Mask technology and delivers 1,600-by-1,200 resolution at 75 Hz and a grille pitch of 0.25 mm.



Left to right Shamrock, ViewSonic, and MAG.

Scrapping for attention are two models from Shamrock Technology Corp. (310-946-9392, *www.shamrock-tech.com*). The $340, 15-inch **M569** is a multimedia unit with a 0.28-mm dot pitch and a maximum resolution of 1,024 by 768 at 85-Hz refresh. It includes two 3-watt speakers and a headphone jack. The $640, 17-inch **C705** boasts a maximum resolution of 1,600 by 1,200 at 70-Hz refresh.

Out of the gate from ShinHo Electronics & Communications (800-802-8116, *www.shinhousa.com*) come four monitors. They include two 15-inch machines, the $340 **AV2 585F** and the $370 **AV2 585FS**, a multimedia unit; and two 17-inch models, the $600 **AV2 785F** and the $640 **AV2 765F**. All deliver 85-Hz refresh at 1,024-by-768 resolution.—*Toni Kistner*

RECAP We reviewed 49 17-inch monitors in our issue of October 8, 1996. Our Editors' Choice award went to the Compaq V70, EIZO FlexScan TX-C7S, MAG 0X700T, Optiquest V775, Panasonic PanaSync S17, Samsung SyncMaster 17GLi, and Sony Multiscan 17se II.

SCANNERS

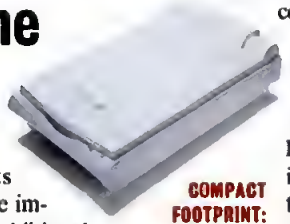
Scanning for Everyone

We just completed our color flatbed scanner roundup, but here are some new scanners that missed the deadline for last issue's hardware feature, "Capture the Color."

Determined to make color scanning cheap and very friendly, newcomer Spot Innoscan (800-611-7768, *www.spot.com.tw*) enters the arena with two flatbed models. The $200 **ScanTak-2C** is a 24-bit, single-pass graphics scanner with a maximum optical resolution of 300 dots per inch (dpi), or up to 2,400 dpi with software interpolation. The scanner connects to your PC and includes Spot's imaging software, Scantastick, which supports scanning multiple images, and ten additional software programs, including Caere Corp.'s optical character recognition (OCR) engine and Ulead's image editor, ImagePals 2 Go!

RECAP We reviewed 17 color flatbed scanners in our issue of Merch 4, 1997, and our Editors' Choice

After testing all those full-size units, we may have been particularly susceptible to the charms of the compact **FotoTak-6**. Spot designed this $200 miniature flatbed photo scanner with the home market in mind.


COMPACT FOOTPRINT: *The Foto Tak-6.*

and a true 600-dpi optical resolution scanner. The unit connects using a proprietary AT-Bus interface card, and it can scan photos of up to 4.5 by 7 inches. The FotoTak-6's desktop interface, FunScan, takes the form of a child's bedroom and makes it fun to launch such included software as Kai's Power GOO and Monotype Card Maker.

With a new angle on scanner design comes the **ArtiScan P24** ($350 street), from Tamarack Technologies (714-744-3979, *www.tamaracktechnologies.com*). This 24-bit, 300-dpi model attaches easily to the PC via a parallel port, as a sheetfed scanner does, but its flatbed design is far more versatile

Sony Picture Quality

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Multiscan® Technology

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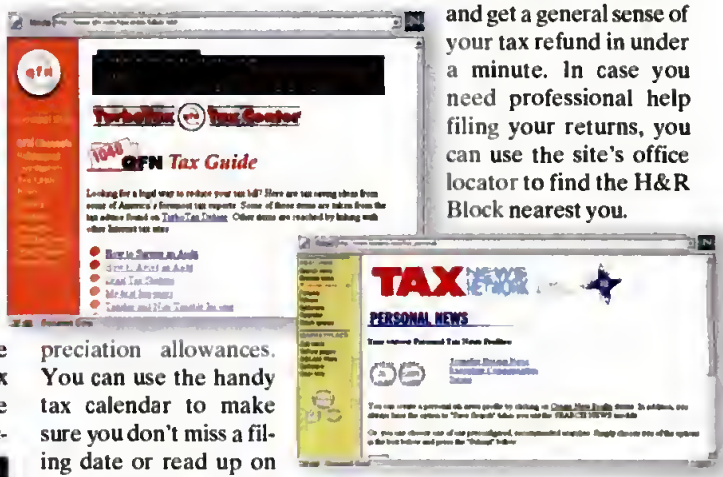
As income tax season hits full stride, you don't have to rely on musty books or your brother-in-law the accountant for guidance. The Web offers a number of sites devoted to tax information and resources to help get you through this annual ordeal.

The Tex News Network (*www.taxnews.com*), from Coopers & Lybrand, delivers a variety of resources for tax professionals. Many site elements are free, including an Ask the Expert section, news summaries, and an interactive alternative minimum tax calculator.

A premium section of the site is available via subscription for $540 per year per person. (A 30-day free trial is available.) It features real-time news developments, personalized searching across several online tax information sources, and full access to Dow Jones's Dow Vision.

Whether you use Intuit's TurboTax or not, you'll find the free **TurboTax Tax Center** (*www.qfn.com/taxcenter*) to be a valuable resource for preparing your taxes. The Quicken Financial Network (QFN) Tax Guide includes tips and links to other tax resources on the Web. There are lists of acceptable medical deductions, explanations of taxable and nontaxable income, and tips for homeowners.

The TurboTax Tax Center also offers the QFN Business Tax Guide, with hints on proper home-office deductions and depreciation allowances. You can use the handy tax calendar to make sure you don't miss a filing date or read up on the newest tax law changes and how they affect you.



TAX HELP: *Web sites from Intuit (above left) and Coopers & Lybrand.*

H&R Block's Web site (*www.handrblock.com*) has free tax tips and tricks, and federal and state forms are available for download in Adobe Acrobat format. The site offers a tax advice blurb of the day, and its tips section includes information for such specific groups as employers and single parents.

The most compelling feature on the H&R Block site is its Tax Refund Calculator. Simply enter your filing status, gross income, federal taxes paid in 1996, number of dependents, and either standard or itemized deductions. Click on Submit and get a general sense of your tax refund in under a minute. In case you need professional help filing your returns, you can use the site's office locator to find the H&R Block nearest you.

A tour of tax Web sites wouldn't be complete without a visit to tbe **Internal Revenue Service**'s site (*www.irs.ustreas.gov*). You can get free tax forms and publications, file for an extension, and learn how to file your return electronically. The site also offers IRS publications for business owners and individuals.—*David Lidsky*

JAVA DEVELOPMENT TOOLS

Add Java Power to Your Site

Java, which promises object-oriented application development and platform independence, has until recently been out of reach to non-programmers. But three products are now making Java programming accessible.

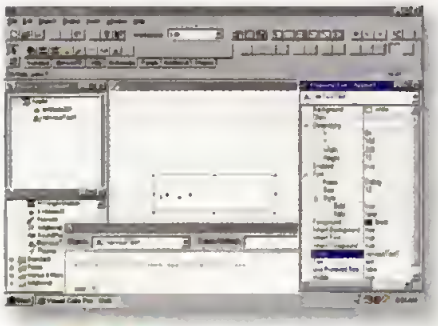
Coda, is a $495 Web site–creation tool, from RandomNoise (415-437-0321, *www.randomnoise.com*), that is written in Java and can be used independently or with any HTML editor. Aimed at Web site designers who want to work with objects rather than write code, the product lets you easily import your own components. And the WYSIWYG interface lets you position objects precisely on your page.

RECAP We reviewed three Java development tools in our issue of January 7, 1997; the public beta version of Visual Café won our Editors' Choice award.

A RAD tool for developers, Asymetrix Corp.'s $99 **SuperCede Java Edition** (800-448-6543, *www.asymetrix.com*) features a Flash Compiler for modifying the source code of a running application and viewing the changes immediately by clicking on the Update button. With SuperCede, you can also create applications by simply dragging and dropping components onto a canvas.

Symantec Corp.'s $199.95 **Visuel Café** (800-441-7234, *www.symantec.com*) comes with 85 preset components and controls that function as soon as you drop them onto the palette.

Visual Café immediately reflects the results of any change you make on the palette within the source code and vice versa.—*Jennifer L. Anderson*



APPLET BUILDER: *Symantec's Visual Café.*

INTERNET TELEPHONY

Phone Home via the Web



NetSpeak Corp. (407-997-4001, *www.netspeak.com*) has released the $49.95 **Video WebPhone 3.0.** The latest version adds real-tima video communications capability to the company's existing Internet phona software package. With Video WebPhone, you can communicate with any WebPhone usar, provided at laast ona party has a PC aquippad with a video capture card and camera.

In addition, WebPhone features MIDI music—to keep your callers occupied while they're on hold—caller ID, and voice mail. Vidao images can even be saved as large, high-resolution graphics in a snapshot album.

The new system requires Microsoft Windows 95 or Windows NT; a PC with a Pentium processor and a 28.8-Kbps connection are racommended.—*Nancy E. Hirsch*

RECAP *PC Magazine* reviewed nine Internet telephony peckages in the issue of October 8, 1996. WebPhone 2.0 won our Editors' Choice.

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ELECTRONIC COMMERCE

Internet Gets the Business

To most of us, the words electronic commerce (EC) refer to the emerging consumer practice of buying books, CD-ROMs, and other goodies over the Internet. There's a lot more to EC, however, than sending your credit card number to Amazon.com to get the latest Danielle Steele novel.

For years, companies such as Harbinger Corp. (800-367-4272, *www.harbinger.com*), Premenos Corp. (800-426-3836, *www.premenos.com*), and Sterling Commerce (800-299-4041, *www.stercomm.com*) have been supporting business-to-business EC that's based on electronic data interchange (EDI). In addition to supplying the necessary EDI software, these companies have supplied their customers with access to private value-added networks (VANs), which in turn provide companies with a secure way to use the Internet for sending purchase orders, invoices, and so forth.

Business-to-business transactions using the existing infrastructure of the Internet, however, were not supported. But Harbinger, Premenos, and Sterling now have such offerings.



EXPRESS COMMERCE: *Harbinger Express lets you use a browser to exchange EDI documents.*

The new Internet-related additions to the Harbinger product family are the **TrustedLink Guardian for UNIX** and a new version of Harbinger's flagship EDI software, **TrustedLink Commerce**; the two products are sold together in a $2,695 bundle. A Microsoft Windows NT Workstation version of TrustedLink Guardian should be available by mid-1997. Using SMTP (Simple Mail Transfer Protocol), data encryption, and Harbinger's Internet Value-Added Service (IVAS), TrustedLink Guardian can send documents generated with TrustedLink Commerce. With these two products, businesses can also send EDI documents using a VAN.

In addition, Harbinger is offering a new service called **Harbinger Express** ($495 set-up fee plus $29.95 monthly). The service lets companies use browsers to exchange documents, which are then automatically translated from HTML to EDI format.

In the first quarter of this year, Premenos is scheduled to release its $25,000 **Templar WebDox for NT**. WebDox lets you securely transmit EDI forms over the Internet; businesses at each end can view documents via a Web browser. WebDox can also be configured to work in conjunction with online catalogs, so that a customer can order a product from a company's online catalog. WebDox generates and transmits the appropriate forms to the company.

Sterling Commerce is also offering products that allow its customers—particularly smaller businesses—to take advantage of the Internet. Their newest product is the **EC Gateway for the Internet**, which is composed of Sterling's GenTran:Server (prices start at $20,000), GenTran:Dataguard (price depends upon configuration), and Connect: Firewall (price depends upon configuration). These components ensure the management of commerce-related information, encryption, and security, respectively.—*Sarah L. Roberts*

DESIGN TOOLS

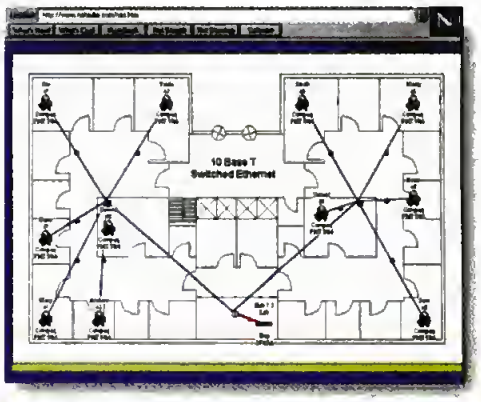
Mapping Out a Grand Plan

Even for the most savvy of networking gurus, designing a network is a daunting proposition. Determining which products are needed from which vendors, resolving interoperability issues, and deciding on the logistical placement of devices on the network is no small task. With tools from ImageNet, (617-239-8197, *www.imagenet-cane.com*), Network Tools (408-571-2600, *www.networktools.com*), and NetSuite Development (800-638-7848, *www.netsuite.com*), however, you can begin to tame the task of network design.

NetSuite has new releases of its sophisticated suite of packages: the $2,500 **NetSuite Advanced Professional Design 2.0**, the $1,000 **NetSuite Toolkit**, and the $2,000 **NetSuite Professional Audit**. This ensemble has added several features, such as the whiteboard mode, that make it easier to construct your network. The whiteboard mode lets you generate network design on the fly and suspend validation, so you can test an idea before locking it into your design.

The NetSuite Toolkit works to convert your network designs into HTML documents, so you can post them on the Web. It also has an IP calculator that helps you plan IP subnets and generate node addresses. The Professional Audit component includes a discovery engine that hunts down information on your network devices, so you don't have to make manual inspections.

Competing on similar ground is ImageNet's $8,000 **CANE for Windows NT**. CANE includes intelligent drawing and validation tools that help get you started, and it has an extensive library of network product components, which is handy when you're deciding which vendor's product you want to add to your network. You can also add modules to supplement CANE, such as the $1,900 IP Planner, which helps you plan IP networks. The basic package includes the VLAN planner to help you unravel the design of a Virtual LAN or VLAN.



SWEET DESIGN: *NetSuite offers a variety of tools that help you plan and set up the perfect network.*

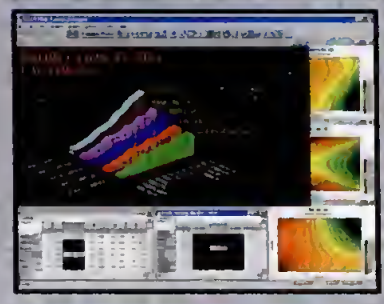
Network Tools' $4,995 **Caliper** is a LAN/WAN design tool. This product lets you create network designs, produce a bill of materials or products you need for your network, and generate detailed drawings. But Caliper's real hook is its add-on, **Virtual Agent Professional**. Priced at $9,995, Virtual Agent allows you to run your dream network on any SNMP management platform before setting it up, so you can get an idea of how manageable the potential configuration is.—*SLR*

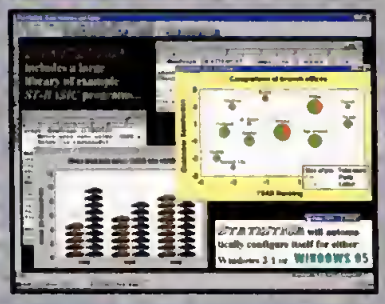
STATISTICA

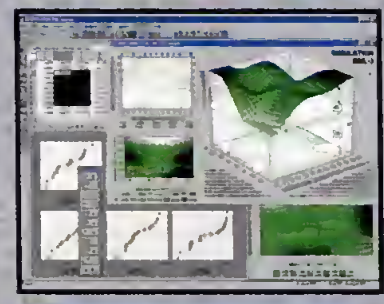
Windows 3.1 and WINDOWS 95/NT

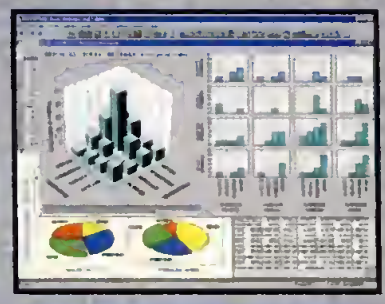


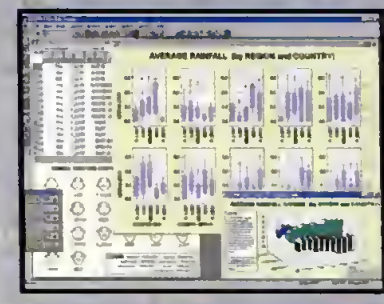


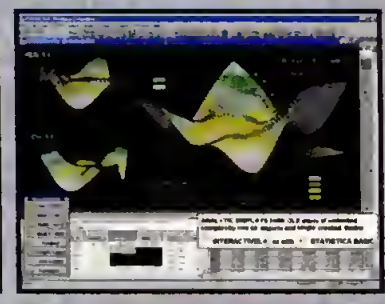


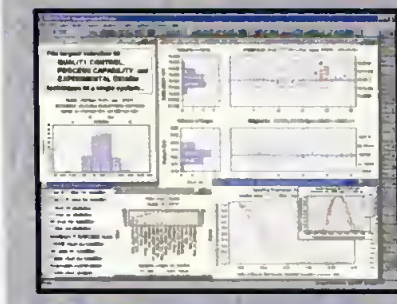


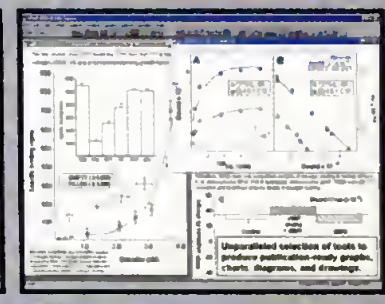


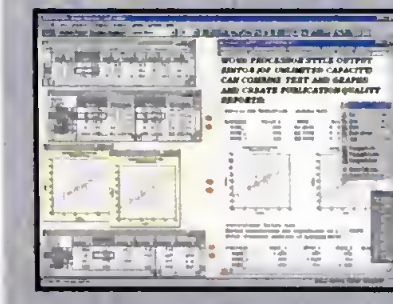














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First Looks

Going with the Flow

These programs expand the definition of diagramming and enhance ease of use.—By J.W. Olsen and Barry Simon

If a picture is worth a thousand words, then for many businesses a well-done technical illustration, flowchart, or network diagram is the equivalent of at least several volumes. But the major programs available for putting diagrams and illustrations together offer a wide variety of features and abilities.

Since our last review of diagramming software ("Flowcharting Software," May 30, 1995), the lay of the land has changed. For one thing, what was a world divided between Microsoft Windows 3.1 and DOS has evolved to become one where Windows 95 holds sway and Windows NT is rapidly becoming more popular.

EVOLUTION OF THE SPECIES

Several of these programs have evolved to become much more



than a way to place symbols on a screen for eventual printing or placement in a presentation or report. The most advanced diagramming products are becoming an environment for creating applications.

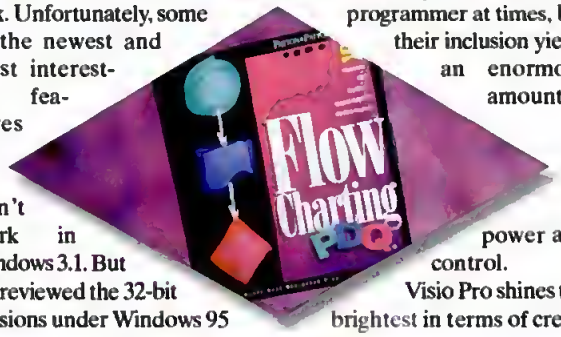
Because of the increasing fragmentation of the market, we looked at a mixed bag of diagramming programs. SmartDraw Software's $49 SmartDraw 3.0 and Patton & Patton's $125 Flowcharting PDQ represent the old guard of diagramming. They focus on making the creation of complex illustrations quicker and easier. Although they have little or no ability to create programs, these two programs stress the



quick creation of a credible flowchart or hierarchical diagram.

The new guard is represented by Micrografx's $299 FlowCharter 7 and Visio Corp.'s $350 Visio Professional 4.5. In addition to creating complex diagrams, these two programs can serve as centers of applications creation.

All four products help with the transition to the 32-bit world by providing a 16-bit version (for Windows 3.1) and a 32-bit version (for Windows 95 and Windows NT) in the same box. Unfortunately, some of the newest and most interesting features don't work in Windows 3.1. But we reviewed the 32-bit versions under Windows 95





and found that the ability to create a range of diagrams is only the beginning of what these products can do.

The freshening cycles of these programs are slightly out of sync. As a result, we reviewed the base-level FlowCharter alongside the higher-level Visio Pro. The two programs cost roughly the same amount of money, however, and Micrografx plans to match many of Visio Pro's features—and introduce a few of its own—when it is revamped this summer.

FOUR-WAY STREET

Of the four programs, FlowCharter and Visio Pro set new standards for user interactivity. To reduce diagramming anxiety, Flowcharting PDQ and SmartDraw stress user-friendliness, but they don't help much with the task of turning a diagram into a database application. Visio Pro's inclusion of both Visual Basic for Applications and ODBC database links requires the skill of a programmer at times, but their inclusion yields an enormous amount of power and control. Visio Pro shines the brightest in terms of creat-

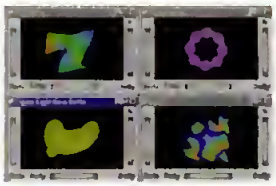
INSIDE

HIGH STANDARDS: Adobe Acrobat 3.0 adds versatility to the electronic imaging world. For a full review, see *page 54.*





MASS STORAGE: Fujitsu and Olympus weigh in with 230MB portable optical drives. See *page 64.*



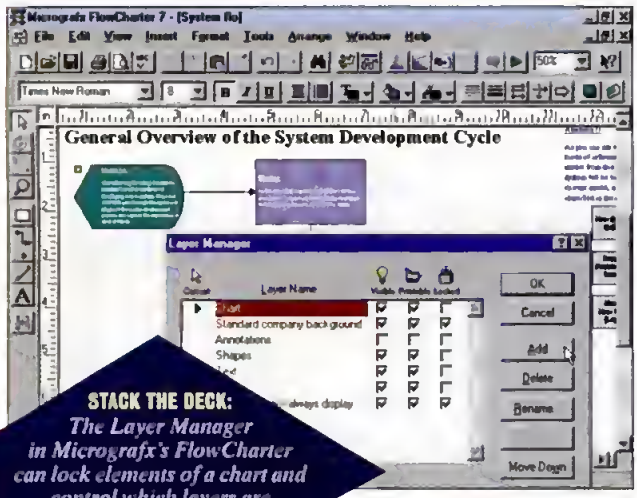
MATH-O-MATIC: Axion can turn your PC into a math whiz. See *page 73.*

More Products Reviewed...

PhotoPad 60
PhotoPlus 60
Snapshot Photo Scanner 1 60
Threa digital cameras 64
Microsoft Picture It! 65
Partition-It 66
PartitionMagic 3.02 66
Quick View Plus 4.0 66
HeadLiner 70
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WinWhatWhere 97 76

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PHOTOGRAPHY BY THOM O'CONNOR



STACK THE DECK: *The Layer Manager in Micrografx's FlowCharter can lock elements of a chart and control which layers are visible, on screen and in print.*

ing network and software diagrams, and it can export any of its files to HTML for placement on either an intranet or the Web. With its Living FlowCharts and automatically numbered objects, FlowCharter builds upon its traditional flowcharting core to meet the needs of professionals in the areas of analysis, and business and process control.

Meanwhile, expect others to catch up. Corel's CorelFlow, Clear Software's allClear (recently acquired by SPSS), and Kaetron Software's TopDown Flowcharter will substantially revamp their products in the coming months.

The package you choose depends as much on what you need to diagram as on how much control of your PC you want to cede to the program.

Micrografx Inc.

FlowCharter 7

Each release of Micrografx's FlowCharter 7 (formerly ABC FlowCharter) has stretched the definition of diagramming software. This $299 version is no different, because it mixes tantalizing treats with the program's solid flowcharting and diagramming abilities.

FlowCharter has an unequaled library of 3,800 symbols for use in building a wide variety of charts and diagrams. The product has notable depth in terms of its business process reengineering (BPR) and total quality management (TQM) abilities.

A subset of the tools found in Micrografx's Designer has been added to FlowCharter. With them, you can create a wide variety of new shapes and save them for future use. FlowCharter's Layer Manager lets you create layers of elements, such as backgrounds and logos, and lock them in place. You can even hide layers, such as those containing annotations.

A big bonus is the inclusion of Living FlowCharts, a feature that helps guide users through the maze of a previously designed, complex, business-process diagram. Think of it as a road map for navigating flowcharts. Each object in a diagram can have an associated dialog box that walks users through the chart, based on the answers they provide. You can use applications of this type to show a new employee a company procedure or to demonstrate the way to fill out a form interactively. The missing link is a viewer utility—expected this spring from Micrografx—that will let users without FlowCharter run Living FlowCharts.

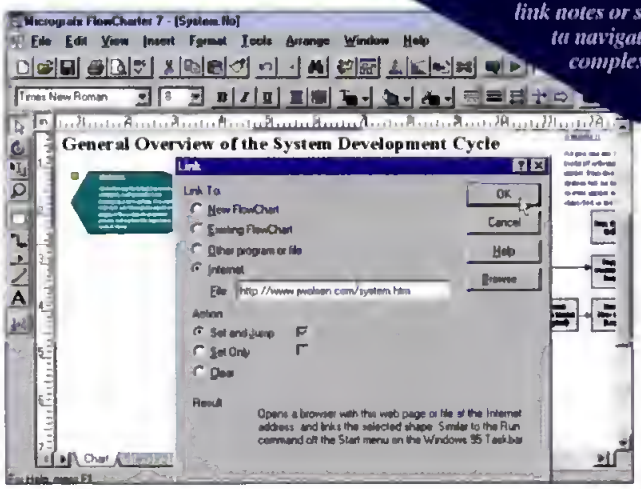
FlowCharter's CoolSheets offer what is arguably the easiest approach yet to creating templates. To produce a hierarchical pyramid diagram using a CoolSheet, we answered a few questions about the number the of diagram's sections and their characteristics. We then added our text, fill colors, and background patterns, and the project was done.

A handy Link function in FlowCharter associates an object with an external diagram or program—or a Web site. Users can then move seamlessly from an object to an associated Web page. In addition, the program's WebCharter feature maps Web sites—right down to the varying levels of links you want. Clicking on objects in a WebCharter diagram takes you to related pages on the Web.

FlowCharter can create Visual Basic scripts automatically based on any chart you've made. Add in the program's VB editor and 500 publisbed OLE automation APIs and events and you have an applications powerbouse that will be further augmented later this year with the expected addition of VBA.

If you demand powerful and diverse traditional flowcharting or business-process analysis and an instant application builder, look no further than Micrografx's FlowCharter 7.

FlowCharter 7
List price: $299; competitive upgrade, $129
Requires: 16MB RAM, 86MB hard disk space; Microsoft Windows 95, or Windows NT 3.51 or later
Micrografx Inc., Richardson, TX
800-603-0074; fax, 716-673-0906
www.micrografx.com
Circle 420 on reader service card.



ENTER HYPERSPACE: *Flow Charting PDQ's hyperlink functions make it easy to link notes or subcharts, and to navigate through complex charts.*

Patton & Patton

Flow Charting PDQ

Patton & Patton's Flow Charting PDQ—the successor to Flow Charting 4 Windows—strives to achieve ease of use rather than emphasizing new features, functions, and programmability. To achieve that goal, it takes a relatively minimalist approach, despite its $125 sticker price.

As with many other diagram-

Flow Charting PDQ
Street price: $125; competitive upgrade, $69
Requires: 16MB RAM, 5MB hard disk space; Microsoft Windows 95 or Windows NT
Patton & Patton, Morgan Hill, CA
800-525-0082, fax, 408-778-9972
www.patton-patton.com
Circle 422 on reader service card.

Editors' Choice

• Visio Professional 4.5

PC MAGAZINE EDITORS' CHOICE

In the last two years, the flowcharting and diagramming market came to a fork in the road: One way pointed toward the traditional tasks of placing icons on the screen, the other led to using these symbolic programs as a way to create novel applications.

Visio Corp.'s $350 Visio Professional 4.5 earns our Editors' Choice award because of its ability to take both roads at once. Not only is Visio Pro a fine basic diagramming tool with a good library of symbols, but its implementation of automation functionality leads the pack. In particular, through VBA support and Visio Pro's tight communications with external data and major third-party applications, Visio Pro can be the center of programming efforts.

Visio Pro is also the only product in our roundup that supports output of all of your diagrams to HTML for posting on the Web or an intranet. And in spite of all its capabilities, Visio Pro manages to retain the inviting drag-and-drop interface that has made this program so popular.



Meanwhile, Micrografx's FlowCharter 7 merits an honorable mention for its ease of use and automation features. In some respects, FlowCharter is half a step behind Visio Pro. Its unique Living FlowCharts makes navigating the most complex process diagrams easy even for flowchart-phobic users. Although the program has VB scripting, it lacks the VBA and HTML output support that would have made FlowCharter an Editors' Choice contender. Look for a midsummer upgrade to bring these additions.

Patton & Patton's $200 Flow Charting PDQ and SmartDraw's $50 SmartDraw retain their focus on making diagramming easier. They include only minimal automation capabilities—primarily through OLE 2.0. SmartDraw in particular may be attractive to those who have only an occasional need to create diagrams.

ming products, you begin your design by clicking on an object, line, or text button, which causes the toolbar to display appropriate options. In addition to the selector button, a button on the left of the work space hides and restores the current symbols palettes—a good way to keep them out of the way but still handy.

Adding, modifying, or moving objects on your chart is intuitive, so you quickly come up to speed with PDQ, and well-designed documentation awaits if needed. Unlike with other diagramming products, however, the size of an object doesn't automatically expand when you add text, so you must manually resize the object after text is entered. And if you delete text that overwrites the borders of an object, the lines don't reappear until you refresh the screen.

Patton & Patton has improved some aspects of its flowcharting program. More than one template may now be open at a time, and zooming in and out is more flexible. You can now connect objects by clicking on one object then dragging a line to the other. Unfortunately, when working on a diagram, you still can't rotate text or other objects, and print preview has not yet been added to this program.

Like FlowCharter 7, PDQ acts both as an OLE server and a client, but unlike Visio Pro, it can't create VBA programs.

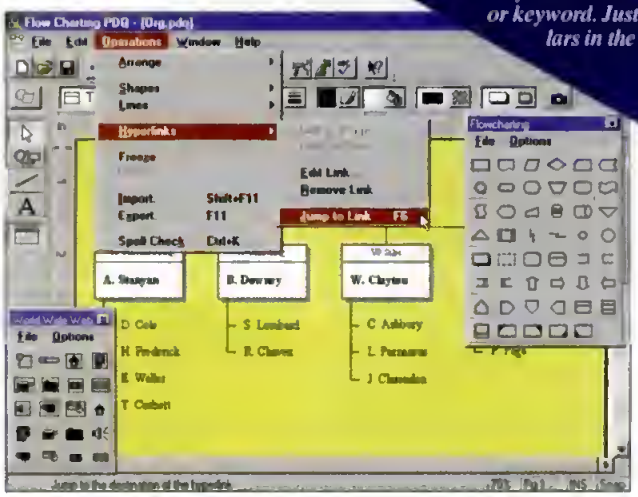
If the $125 price of Flow Charting PDQ makes you blanch, there's also a $49 scaled-down version that can be downloaded from the company's Web site.

SmartDraw Software Inc.

SmartDraw

SmartDraw Software's $49 SmartDraw 3.0 hides surprising depth behind its easy-going interface. An excellent resource for the graphically challenged, SmartDraw is for those who need to create occasional diagrams but don't want to learn how to use a more complex tool.

With its help for selecting the right template, new-user hints that pop up the first time you use a function (or when you make a mistake), and skillful integration of drag-and-drop operations, you may never have to open the program's well-written manual. You create diagrams by dragging and dropping lines and shapes from a toolbar, and symbols from the program's 1,500-object library. You then add connectors, text, and color from pull-down menus or right-click context menus. After you specify a symbol's name or keyword, the program's clever Find function makes quick work of locating exactly the correct symbol. As with FlowCharter,



FINDERS KEEPERS: *SmartDraw locates elusive symbols in its library by name or keyword. Just fill in the particulars in the dialog box.*

SmartDraw 3.0
List price: $49
Requires: 8MB RAM, 14MB hard disk space; Microsoft Windows 3.1, Windows 95, or Windows NT
SmartDraw Software Inc., San Diego
800-501-0314, fax 619-549-2830
www.smartdraw.com
Circle 421 on reader service card

you can create and save new shapes as well as rotate shapes, symbols, and imported objects to any angle. All in all, SmartDraw makes good use of snap-to grids, automatic sizing, and various alignment methods. Generally, the result is a professional-looking diagram.

Objects and groups of objects keep their connectors intact when moved. And when you add or delete elements, connectors are automatically added or deleted.

New to SmartDraw are export filters for .GIF and JPEG images. There's even an option for adding interleaving and transparency for Web pages. The print preview feature was a real time saver.

For floor plans and similar drawings, the program's Automatic Dimensioning labels selected lines with their lengths. Then when you rescale the drawing, the labels are updated automatically.

As far as programming goes, SmartDraw is an OLE 2.0 server. Unfortunately, it doesn't support OLE automation—as do FlowCharter and Visio Pro—or VBA—as does Visio Pro. So you can create drawings within Microsoft Office and other compliant applications, but you can't create standalone programs. On the other hand, SmartDraw picks up Microsoft PowerPoint's color-scheme protocols, so SmartDraw diagrams blend in well with your presentations.

In short, SmartDraw 3.0 provides remarkable ease of use and ample power for the occasional diagrammer. And all at a bargain basement price.

Visio Corp.

Visio Professional

PC MAGAZINE EDITORS' CHOICE

A lot more is noteworthy about Visio Corp.'s $350 Visio Professional 4.5 than its inclusion of Microsoft's Visual Basic for Applications (VBA) 5.0. The granddaddy of point-and-click diagramming software, Visio Pro has managed to retain its superb ease of use and flexible interface, while doing an outstanding job of introducing integration with applications.

The program comes with 2,100 symbols that run the gamut of uses, from diagramming networks, to charting application logic, to illustrating and documenting business processes. The program retains the drag-and-drop drawing capability that has defined this program from the start, but Visio Pro goes a step further than the other programs by emphasizing and using the intelligence built into its objects.

The inclusion of database connectivity via ODBC with the other automation tools lets developers make graphical front ends to databases useful for many tasks, including sales-force automation. For example, a programmer can set up a template that allows a furniture sales person with a notebook computer to generate a database entry at the customer's site. This entry is then linked to a Visio diagram for each sales prospect.

And not only can furniture symbols be dragged and dropped into place on a Visio floor plan, but macros can be linked to the creation and deletion of objects. In this way, the database can be kept in sync with company servers and completed orders can be generated automatically.

Links to Excel can track costs and warehouse availability and even display them in Visio. There is even a wizard that produces a block diagram of the relations between tables and fields in a database.

New to this version are a wizards that help with building charts and diagrams. There are several new sets of special-interest symbols, and for drawing diagrams of computer networks, Visio Pro is without peer. There's a wizard that together with more than 300 vendor-specific smart shapes of computers, communications, and networking gear can make quick work of describing just about any LAN.

For flowcharting-software-development projects there are templates of objects for various systematic approaches (such as Nassi-Schneiderman and Yourdon-Coad diagrams). In addition, this version adds something special for software designers: a library of the shapes for documenting the Windows 95 user interface of an application.

Visio Pro can convert any diagram into an HTML file for Web distribution, and the program includes a wizard to diagram a Web site. There are even tools for using Visio Pro to understand the internal workings of the program itself. Our favorite is the wizard that documents the smart shapes in a stencil.

Visio Professional 4.5 is a program with a dual personality: It's both a substantial upgrade for those with high-end automation diagramming needs and a program for first-time users who want to create a network diagram or flowchart. □

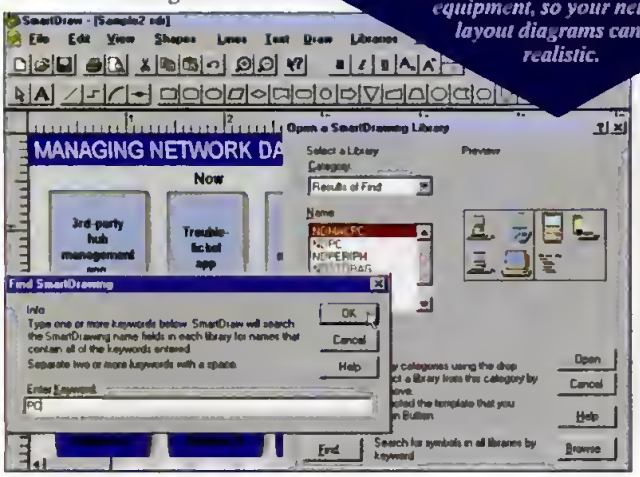
Visio Professional 4.5
Street price: $350
Requires: 16MB RAM, 55MB hard disk space; Microsoft Windows 95 or Windows NT
Visio Corp., Seattle
800-248-4746; fax, 206-521-4501
www.visio.com
Circle 423 on reader service card.

Diagraming: Side by Side

✔ YES ✘ NO
Products listed in alphabetical order
Red type denotes Editors' Choice

	FlowCharter 7	Flow Charting PDQ	SmartDraw 3.0	Visio Professional 4.5
Price	$299 (list)	$125 (street)	$49 (list)	$350 (street)
Shapes	3,800	540	1,500	2,100
User-interactive flowcharts	✔	✘	✘	✘
Support for layers	✔	✘	✘	✔
OLE 2.0 client/server	✔✔	✔✔	✘✔	✔✔
OLE 2.0 automation	✔	✘	✘	✔
Can create VBA applications	✘	✘	✘	✔
Microsoft Office 97 compatibility	✔	✘	✘	✔
Direct database and spreadsheet access	✔	✘	✘	✔
HTML output	✘	✘	✘	✔

LAN-O-MATIC: *VisioPro's shapes include diagrams of actual computer equipment, so your network layout diagrams can be realistic.*




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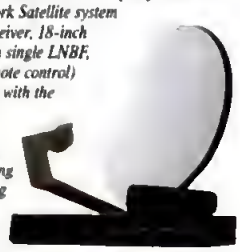
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1. Open the foldout page
2. Insert this sheet with
   1. Front side touching the free page
   2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet

Folded edge of the page

GbsSlipSheet-001

Inverted Foldout slip-sheet

1. Open the foldout page
2. Insert this sheet with
   1. Front side touching the free page
   2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet

1. Follow instructions on the other side

Inverted Back

GbsSlipBack-001B

Back

1. Follow instructions on the other side

UNLOCK THE POWER

He forges a path through the raging blizzard. Waiting in the post office is a Gateway Solo™ 2200 portable PC, a force more powerful than the winter storm outside. Next to it is a high-performance G6-200 Pentium Pro processor-based professional PC. Both systems can be custom configured and are loaded with lots of great features. Microsoft® Office 97 Small Business Edition (SBE) Plus is tailored to the needs of small businesses, and it's pre-installed. Keeping the post office organized was not only going to be easy, it was going to be fun. Office 97 SBE Plus includes MS® Word 97, Excel 97, Publisher 97, Automap Streets, Encarta® 96 and Outlook™ 97. The keykeeper could play post office all day, but duty calls.



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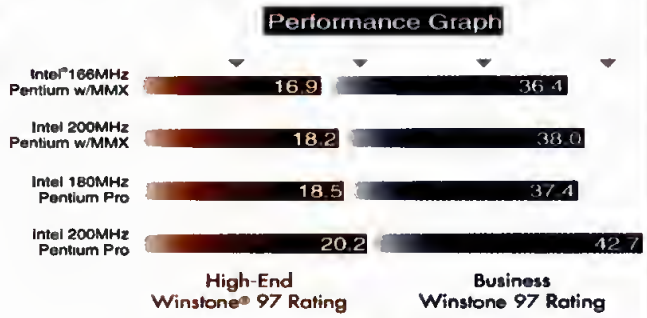
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Ziff-Davis' Winstone 97 Version 1.0 produced scores of 16.9 and 36.4; 18.2 and 38.0, 18.5 and 37.4, and 20.2 and 42.7 Winstone Version 1.0 units on its High-End Winstone 97 suite and Business Winstone 97 suite on Gateway 2000, Inc. PCs configured with 166MHz Intel Pentium Processor with MMX technology, 200MHz Intel Pentium Processor with MMX technology, 180MHz Intel Pentium Pro processor and 200MHz Intel Pentium Pro processor, respectively. All Gateway 2000 PCs tested featured 32MB RAM, 256K RAM cache, 3.8GB hard disk, IDE controller, FAT file system, and no hardware disk cache. Systems include S3 ViRGE/VX graphics adapter, with 4MB VRAM with v1.23m3 driver; 1024x768 with 256 colors; and a refresh rate of 75Hz. Test systems used MS DOS 7.1 and MS Windows 95. All products used in the test were shipping versions available to the general public, and the test and its results were not verified by Ziff Davis

MMX intel inside pentium processor

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***MMX Technology-Enhanced Software Bundle includes Pod™, Eraser™ – Turn About, The Ultimate Human Body Version 2.0, and The Third Dimension™.*

Professional Systems

P5-133

- Intel 133MHz Pentium Processor
- 16MB Synchronous DRAM
- 256K Pipelined Burst Cacbe
- CrystalScan500 .28dp Monitor (13.9" viewable area)
- 2MB SGRAM, 3-D 64-Bit PCI Graphics
- 1.2GB 11ms EIDE Hard Drive
- 12X CD-ROM/3.5" Diskette Drives
- Mini Tower Case
- 104* Keyboard & MS IntelliMouse
- MS Windows 95
- MS Office 97, SBE Plus◆
- Gateway Gold Service & Support for Desktop PCs

$1499 Business Lease' $55/mo.

P5-166

- Intel 166MHz Pentium Processor with MMX Technology
- 24MB Synchronous DRAM
- 256K Pipelined Burst Cache
- CrystalScan700 .28dp Monitor (15.9" viewable area)
- 2MB SGRAM, 3-D 64-Bit PCI Graphics
- 2.5GB 11ms EIDE Hard Drive
- 12X CD-ROM/3.5" Diskette Drives
- Mini Tower Case
- 104* Keyboard & MS IntelliMouse
- MS Windows 95
- MS Office 97, SBE Plus◆
- Gateway Gold Service & Support for Desktop PCs

$1999 Business Lease' $74/mo.

P5-200

- Intel 200MHz Pentium Processor with MMX Technology
- 32MB Sychronous DRAM
- 512K Pipelined Bursl Cache
- CrystalScan700 .28dp Monitor (15.9" viewable area)
- 2MB SGRAM, 3-D 64-Bit PCI Graphics
- 2.5GB 11ms EIDE Hard Drive
- 12X CD-ROM/3.5" Diskette Drives
- Mini Tower Case
- 104* Keyboard & MS IntelliMouse
- MS Windows 95
- MS Office 97, SBE Plus◆
- Gateway Gold Service & Support for Desktop PCs

$2299 Business Lease' $85/mo.

G6-200

- Intel 200MHz Pentium Pro Processor
- 32MB EDO DRAM
- 256K Internal Cacbe
- Vivitron®700 .26dp Monitor (15.9" viewable area)
- STB ViRGE/VX 4MB, 3-D 64-Bit PCI Graphics
- 3.8GB 11ms EIDE Hard Drive
- 12X CD-ROM/3.5" Diskette Drives
- Tower Case
- 104* Keyboard & MS IntelliMouse
- MS Windows 95
- MS Office 97, SBE Plus◆
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- **Kid's BackPack™ III** Includes Schoolhouse Rock!™: Grammar Rock™; Sesame Street: Get Set to Learn®; Math Blaster® Episode 2: Secret of the Lost City; Imo & The King™; Putt-Putt® Goes To The Moon™; and Gateway cow-spotted backpack. **$59**
- **Finance Pack II** *(U.S. Shipment Only)* Includes Quicken® Deluxe 6, Quicken Financial Planner™ 2, Quicken Family Lawyer™ 7, Quicken Parents' Guide to Money™ and a Turbo Tax® 96 coupon. **$69**

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- Canon® BJC®-240 Bubble Jet Printer **$189**
- Canon BJC-70 Portable Bubble Jet Printer **$299**
- Hewlett®-Packard LaserJet 5L Xtra Laser Printer **$399**
- Hewlett-Packard LaserJet 6P Laser Printer **$769**
- MS® SideWinder™ 3D Pro Joystick **$59**
- APC™ Back-UPS® 650 Pro UPS **$329**
- Visioneer™ PaperPort Vx™ **$249**

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  4X read/2X write recordable CD drive with SCSI controller, CD Creator 2 for MS Windows® and three media disks.
- **Iomega® Ditto™ 3200 Internal Tape Backup Unit $199**
  3200MB with compression, nominal 1600MB
- **Iomega Internal Zip™ 100MB Drive $139**
  (includes three 100MB cartridges)
- **Iomega External Zip 100MB Drive $199**
  (before $50 manufacturers rebate)
- **Iomega Jaz® 1GB Drive $429**
  (includes SCSI controller and 1GB cartridge)
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PERIPHERALS

The Big Easies

These two 230MB portable magneto-optical drives make notebook data more portable.—By Bruce Brown

Even as hard disks get bigger and faster, the twin problems of moving large files and backing up a notebook's contents onto removable media remain. Fujitsu Computer Products and Olympus America wade in with similar—though far from identical—portable magneto-optical disk drives that each can hold 230MB on 3.5-inch cartridges.

The $450 Fujitsu DynaMO 230 PC Card Drive connects with your system through its Type II PC Card; the $390 Olympus SYS.230 Universal plugs in to either a SCSI or parallel port, making it suitable for moving data between desktop computers as well as between PCs and notebooks. We put these mini-MO drives through their paces with a Pentium/133 Micron TransPort running Windows 95. Though the DynaMO is smaller and lighter, and can run on battery power, the SYS.230 is less expensive and more versatile, and it set the pace in terms of performance.

Fujitsu Computer Products of America Inc.

DynaMO 230 PC Card Drive

Small, light and ready for the road, the Fujitsu DynaMO 230 PC Card Drive, from Fujitsu Computer Products of America, fits a lot of data into a small space.



POWER MAD: *You can run the DynaMO on battery power, but you won't get very far.*

Installing the 1- by 4.3- by 6.5-inch DynaMO entails plugging its Type II PC Card into your notebook and restarting the system. The first time you use the DynaMO, you have to spend a few minutes loading the drivers. But after that, Microsoft Window 95 consistently recognized and correctly configured the DynaMO every time. The Fujitsu drive and included AC adapter weigh 1.7 pounds, which drops to 1.4 pounds when the power supply is replaced with four AA cells.

Though you can run the DynaMO on batteries, you probably won't want to often, because battery life was disappointing. With standard alkaline batteries (which aren't recommended by Fujitsu), the DynaMO can run for about 10 minutes of continuous operation; with rechargeable nickel cadmium or nickel hydride batteries (not included), you can run the DynaMO for 35 and 55 minutes, respectively.

In addition to its power options, the DynaMO can read from and write to 128MB magneto-optical media. The DynaMO's optical disk's rotational rate is 2,700 rpm, and it has a 128K data cache, which add up to an average seek time of 65 ms and a maximum 1.6-MBps sustained data-transfer rate.

During testing, the DynaMO was slower than the SYS.230: It took 8 minutes, 46 seconds to copy 68.9MB of data, which was 2 minutes, 25 seconds more than the SYS.230 took. Using the Windows 95 Backup utility, the DynaMO compressed the same data to 36.3MB in 20 minutes, 45 seconds.

Eminently portable, the DynaMO is an excellent choice for field work.

DynaMO 230 PC Card Drive. Street price: $450. Requires: 8MB RAM, 1MB hard disk space, Type II PC Card slot; DOS 4.0 or later, or Microsoft Windows 3.*x*, Windows 95, or Windows NT. Fujitsu Computer Products of America Inc., San Jose, CA; 800-626-4686, 408-432-6333; www.fcpa.com. *Circle 418 on reader service card.*



FAST AND FLEXIBLE: *The SYS.230 can run on a SCSI or parallel port, and it is fast.*

Olympus America

SYS.230 SCSI Universal

Weighing in at 2.6 pounds, the 1.8- by 5.4-by 7.5-inch SYS.230 Universal, from Olympus America, is larger and heavier than the DynaMO but more than makes up for it with top-flight performance and flexibility.

The SYS.230's ability to connect via either a parallel or SCSI port makes it the better choice of these two drives if you want to use it with both desktop and notebook computers. In addition, the SYS.230 spins faster (4,200 rpm versus 2,700 rpm) and it has twice the cache (256K versus 128K) of the DynaMO. These factors result in a sustained data-transfer rate of up to 2.6 MBps and an average seek time of under 17 ms.

Copying the same 68.9MB of files as the DynaMO took 6 minutes, 21 seconds; the Backup test took 8 minutes, 25 seconds. In addition to speedy operation, the SYS.230 also lets you daisy-chain up to 7 drives or other SCSI devices, even when attached to a computer's parallel port.

What it sacrifices in weight and size, the SYS.230 makes up for with performance, a flexible interface, and an affordable price tag.

SYS.230 Universal. Street price: $390. Requires: 4MB RAM, 2MB hard disk space; SCSI or parallel port; DOS 5.0 or later, or Microsoft Windows 3.*x*, Windows 95, or Windows NT. Olympus America, Melville, NY; 800-347-4027, 516-844-5000; www.olympusamerica.com. *Circle 419 on reader service card.*

PERFORMANCE TESTS

MO Disk Drives

PC MAGAZINE LABS

The Olympus SYS.230 Universal handily outperformed the Fujitsu DynaMO 230 PC Card Drive, probably because the SYS.230 has a larger cache and faster rotation speed.

We tested these portable magneto-optical drives with a Pentium/133 Micron TransPort notebook with 48MB of RAM and a 1.3GB hard disk, running Microsoft Windows 95. Prior to each test, we defragmented the notebook's hard disk; we then used either the Windows 95 Explorer (File Copy test) or the Backup utility (File Backup test) to move 68.9MB of data to a cleanly formatted 230MB cartridge.

Minutes:seconds	File Copy	File Backup
Fujitsu DynaMO 230	8:46	20:45
Olympus SYS.230	6:21	8:25
	◄ BETTER	◄ BETTER

SCSI GIVES NT THE FUEL NEEDED TO ENERGIZE THE DESKTOP... AND THE GALAXY!

SEE SCSI MAKE NT FLY!

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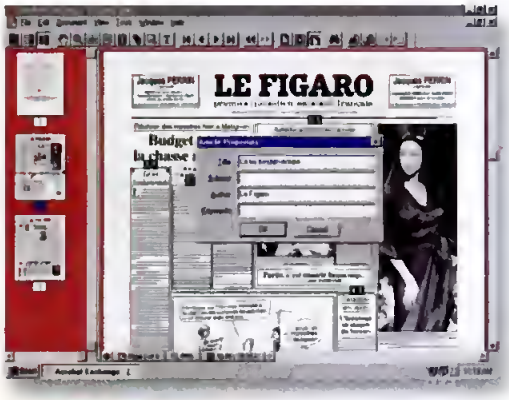
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ELECTRONIC IMAGING

Acrobat's High-Wire Act Improves

Adobe's portable document creator adds tools.—By Edward Mendelson

Adobe's Portable Document Format (.PDF) is the industry standard for electronic documents. Adobe Acrobat 3.0 builds .PDF files from any Microsoft Windows application and—via your scanner—from any printed page. If you just want to view existing .PDF files, go to Adobe's Web site and download the free Acrobat Reader. But if you want to create, modify, or annotate .PDF files, or add links to them, get the $295 Acrobat 3.0 package.



ELECTRONIC BOOKMAKER: *With a mouse click, you can use Adobe Acrobat to tie disconnected text together, so that readers can follow the flow.*

Acrobat 3.0 combines the separate basic and professional Acrobat packages of previous versions. A Windows driver lets you print from Windows applications to .PDF files, and Distiller software lets you create .PDF files from PostScript output. A plug-in scanning module for the main Acrobat program lets you create .PDF files by scanning in printed pages. And a second module, Acrobat Capture, uses OCR technology to convert scanned pages to .PDF files.

In comparison with such rival electronic formats as Corel WordPerfect's Envoy and Tumbleweed Software's Publishing Essentials, .PDF files are slow both to display and search. But .PDF files can be made and viewed on virtually all platforms—including all major flavors of Unix.

Acrobat Exchange—where you modify and index .PDF files created by the Acrobat printer driver—includes new features that allow faster access to .PDF files from your disk and, when viewed across the Internet, through the Acrobat plug-in. When you check Optimize in the Save As dialog box, Exchange creates files that are automatically downloaded over the Web as each page is requested rather than as a single, large file. Optimization also eliminates duplicate background objects and replaces them with pointers to single instances in the file. On our tests, .PDF files without repeated background images or text were actually enlarged slightly when optimized; files with repeated graphic elements can be reduced to a fraction of their original size.

The Exchange program can create thumbnail images for navigation in a .PDF file. And you can manually add outline-style bookmarks and internal and external links to .PDF files and mark them to create connected articles, which lead your readers through documents. Exchange also lets you insert, delete, and rotate pages.

Most electronic document software won't let you modify files after you print them from your applications, but Acrobat's Touch-Up tool lets you alter content, typeface, and point size on a line-by-line basis—provided that your system has the correct fonts. Other tools in Exchange let you attach sticky notes or video clips with a few mouse clicks

Both Acrobat Exchange and the free Acrobat Reader have a built-in text-search feature that can be frustratingly slow. But a file-indexing plug-in for Exchange renders them almost instantaneously; a free plug-in for Reader lets users search existing indexes but not create new ones.

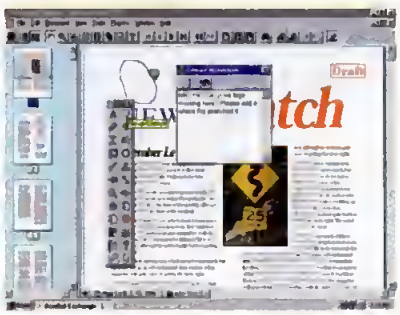
The Acrobat Capture plug-in uses an extremely accurate OCR engine to convert graphics files into searchable text-based .PDF files. When the OCR engine is uncertain, the program displays the text as graphic images, which you can replace with text by using the Touch-Up plug-in. To save time, you can leave the graphic images in the .PDF files. These features make Adobe Acrobat the only software in this category suitable for high-volume, batch-processed OCR work.

With its Web-optimized files and high-value add-ins, Adobe Acrobat makes .PDF the industry-standard format for electronic documents.

Adobe Acrobat 3.0. List price: $295. Requires: 16MB RAM, 40MB hard disk space, Microsoft Windows 3.1 or later, Windows 95, or Windows NT 3.51 or later. Adobe Systems Inc., San Jose, CA; 800-272-3623; www.adobe.com/acrobat. *Circle 417 on reader service card.*

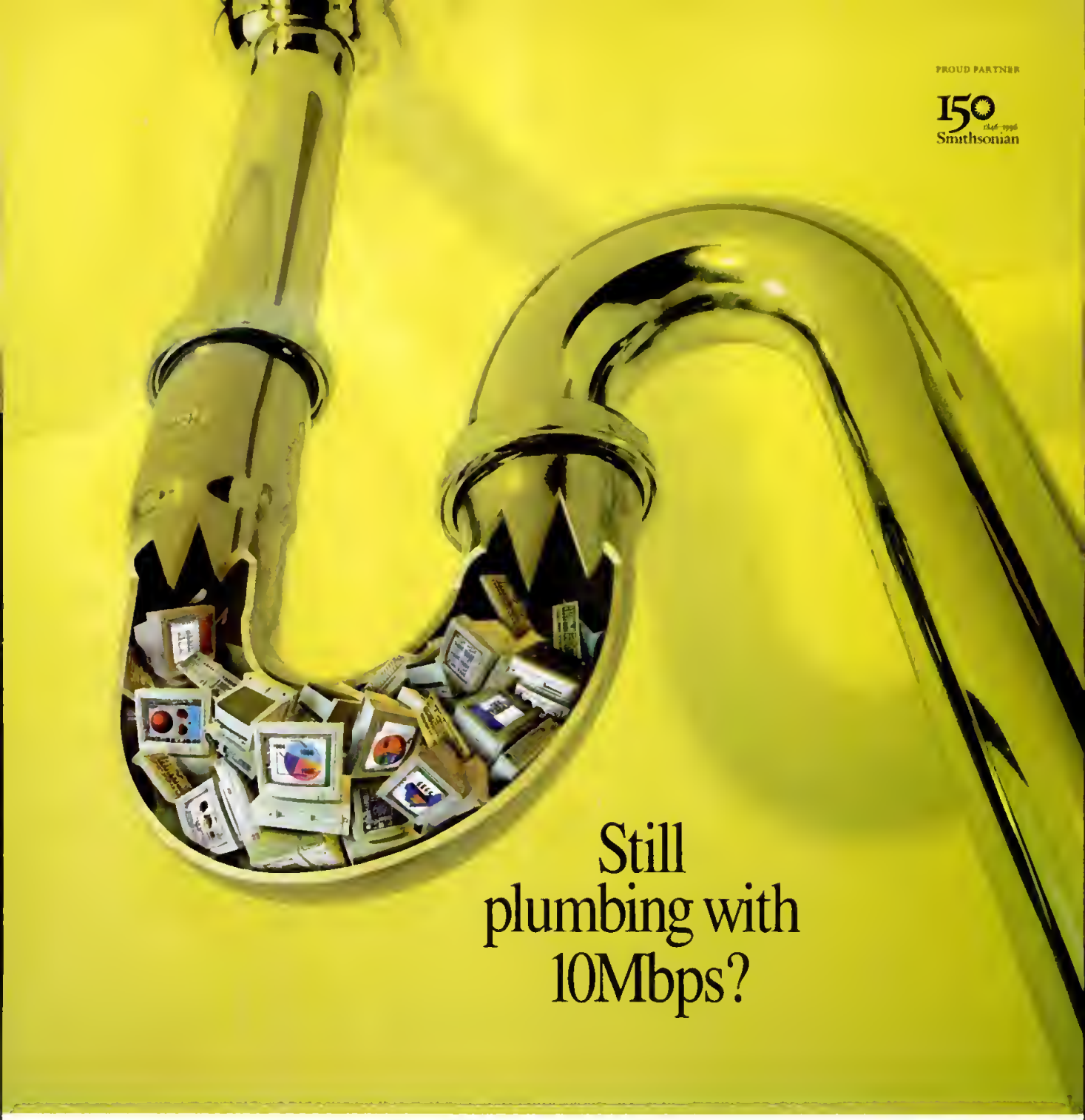
Acrobat Paper Clips and Pushpins

Adobe Acrobat 3.0 comes loaded with versatile plug-ins, but third-party vendors have stepped in to enhance .PDFs. We tested two Acrobat Exchange plug-ins—Aerial and Re:Mark—from Software Partners (415-428-0160, *www.buckaroo.com or www.ambia.com*).



Aerial adds navigation tools called "paper clips," which resemble browser bookmarks and point to any page in a .PDF file. A paper clip attached to a .PDF file anywhere on your disk is accessible from a single list of all paper clips. Another tool in the package is a converter that exports .PDF files in rich-text format (.RTF), which is readable by all word processors.

Re:Mark lets you attach any file to a .PDF document and uses a pushpin icon that launches or detaches the file. You can use your mouse to draw sketches and handwritten comments on .PDF files, and you can add underlining and highlighting to the marked text, with pop-up comments attached. The package includes the same .RTF converter included in Aerial.—*EM*



Your network's stopped up. Your users are frustrated. Time to move to 100Mbps.

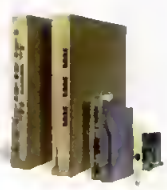
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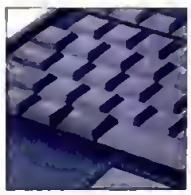
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*Preliminary measurement

OUR NOTEBOOKS AS SEEN FROM A HOLY COW PERSPECTIVE.

intel inside pentium® PROCESSOR

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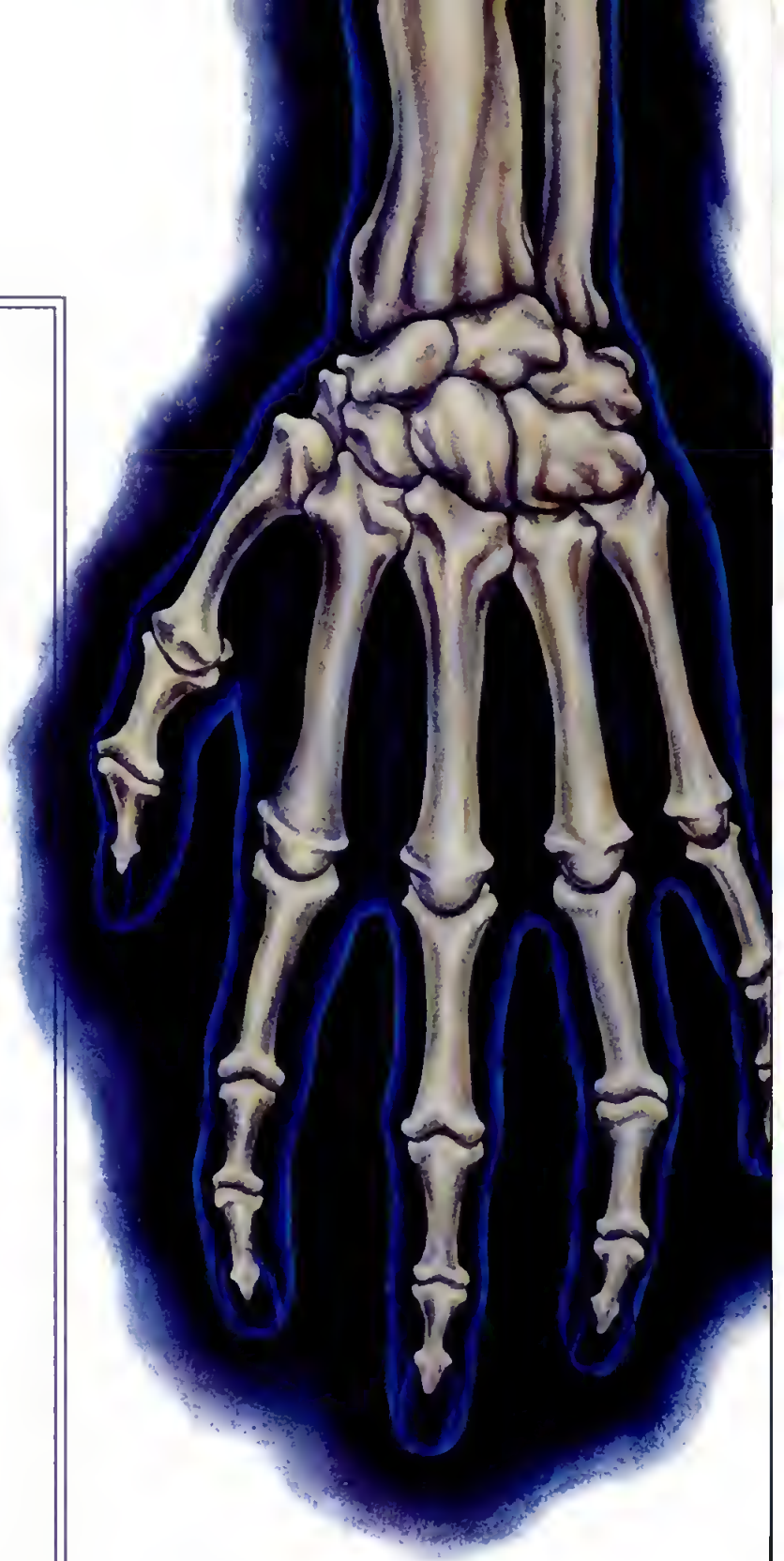
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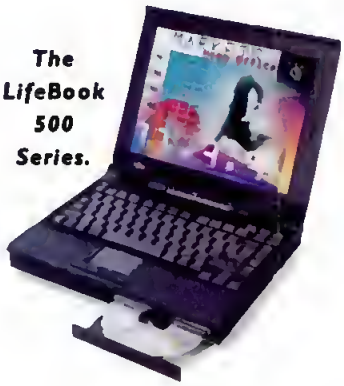


Every LifeBook product must pass tha 18,000 open and close test. Or it's not a LifeBook.

intel inside

pentium® PROCESSOR

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Introducing the Lifebook™ 500 Series. A hands-on kind of machine to make your daily experience with a notebook personal and productive, not difficult and really annoying.

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② **A PALM REST for comfort. A newly designed keyboard for convenience—like giving those darn arrow keys some space.**

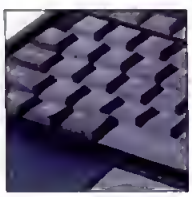
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SCANNERS

Worth a Thousand Pixels—at Least

These snapshot scanners let you quickly digitize small photo prints, but don't expect perfection.—By Daniel Grotta and Sally Wiener Grotta

If you're up to your ears in photo prints, you might want to consider adding an inexpensive snapshot scanner to your PC. Epson America's $199 PhotoPlus, Eastman Kodak's $199 Snapshot Photo Scanner 1, and Polaroid Corp.'s $250 PhotoPad connect via parallel ports and are surprisingly easy to operate.

All three scanners use Datastorm's scanning engine, so scan times were comparable. Each fits easily on your desktop, digitizes originals of up to 4 inches wide, saves images in any of a number of popular bitmap formats, and helps get your snapshots from those shoe boxes into your PC. Though the PhotoPlus and Snapshot Photo Scanner 1 are limited to a top resolution of 200 pixels per inch (ppi), the PhotoPad can scan color at twice that level.

All three of these mini-scanners produced pronounced banding on a variety of test scans, so they will probably remain in the realm of home PC users.

Epson America Inc.

PhotoPlus

The most versatile of these three mini-scanners, the PhotoPlus, from Epson America, supports the widest range of scan modes and includes software for digitizing business cards.

To get going, select color, black-and-white, or business-card mode and indicate whether you want portrait or landscape. Then set the snapsbot dimensions (up to 4.1- by 10-inch prints) and the desired resolution (from 50 to 200 ppi for color and up to 400 ppi for monochrome).

After the scan, you can adjust brightness and saturation with slider controls while you compare before and after versions. You can also apply Epson's ColorTrue Enhancements to optimize picture quality.

Epson includes Create Cool Stuff Fun Pak, which has a basic set of image-editing tools and filters as well as templates for creating invitations, signs, screen savers, greeting cards, and even refrigerator magnets. The included Corex CardScan SC is a simple but effective business-card scanning utility and database. Using CardScan may try your patience though, because the PhotoPlus waits 30 seconds between scans.

The PhotoPlus's scanning head is removable, so you can scan flat surfaces, such as book pages. The removable head is also easier to clean and lets you clear the system's optical element. PhotoPlus scans were generally dark with oversaturated colors, although most flaws were correctable.

Quick and easy, the PhotoPlus does it all, from business cards to greeting cards.

PhotoPlus. List price: $199. Requires: 8MB RAM, 50MB hard disk space, parallel port; Microsoft Windows 3.1 or Windows 95. Epson America Inc., Torrance, CA; 800-463-7766, 310-782-0770; www.epson.com. *Circle 412 on reader service card.*



Polaroid's PhotoPad, Eastman Kodak's Snapshot Photo Scanner 1, and Epson America's PhotoPlus.

Eastman Kodak Co.

Snapshot Photo Scanner 1

Eastman Kodak Co.'s Snapshot Photo Scanner 1 (SPS1) manages to automate just enough functions to make its setup and use just about foolproof.

The included CD-ROM provides easy step-by-step instructions. The scanning head is not removable, although it can be raised for cleaning and clearing jams. The print dimensions are set automatically, and the SPS1 scans 4- by 11.5-inch panorama prints but operates at only 200 ppi.

You can begin scanning after you set the JPEG image compression level, choose metric or English measurements, and display either the step-by-step or the expert scanning options. Once an image is scanned, you can rotate or trim it, adjust the brightness and contrast, or click on SmartFix for automatic adjustments. The before and after windows can zoom in on details. SPS1 gives users the option of transferring an image directly to PhotoEnhancer or Kai's Power GOO—both of which are included—or saving it in a variety of formats.

Though images were generally good, SPS1's scans tended to produce unrealistic colors, and tbe mechanism—while the quietest of the three—caused a very slight elongation of the image.

The Snapshot Photo Scanner 1 is for those who need instant scans with few adjustments.

Snapshot Photo Scanner 1. List price: $199. Requires: 8MB RAM, 2MB hard disk space, Microsoft Windows 95. Eastman Kodak Co., Rochester, NY; 800-235-6235; www.kodak.com. *Circle 413 on reader service card.*

Polaroid Corp.

PhotoPad

The most expensive of these three scanners, Polaroid's $250 PhotoPad trades scan area and software for resolution.

The PhotoPad can scan originals up to 4- by 6-inches only, but it does so at up to 400 ppi. The system produces 24-bit color or 256 color scans, and the device comes with a calibration target for accurately setting the scanner's default values. On the downside, the PhotoPad's scanning head is not removable, and scanning tools are limited to brightness adjustments and Polaroid's color-correction feature, SuperColor.

Despite its Spartan nature, the PhotoPad gave us the best scans and the truest colors of the three. At full resolution, it turned a 4- by 6-inch snapshot into a 9.8MB file (compared to 1.9MB for the PhotoPlus and 2.6MB for the SPS1), which translated into greater detail in the image.

For scanning—and little else— PhotoPad does the trick.

PhotoPad. Street price: $250. Requires: 8MB RAM, 8MB hard disk space; Microsoft Windows 3.1 or Windows 95. Polaroid Corp., Cambridge, MA; 800-343-5000; www.polaroid.com. *Circle 414 on reader service card.*

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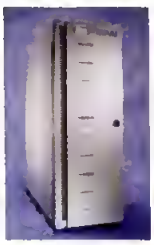
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DIGITAL PHOTOGRAPHY

Point and Shoot for PCs

These three cameras advance the state of the art for digital shutterbugs.—By Daniel Grotta and Sally Wiener Grotta

Until recently, most entry-level digital cameras were boxy affairs with limited features that yielded relatively crude pictures. The latest crop of filmless cameras—the $600 Fujix DS-7, the $900 Olympus D-300L, and the $1,000 Ricoh RDC-2—look and feel more like point-and-shoot 35-mm cameras and produce some of the best images we've seen yet.





MOVING PICTURES: *The Fujix DS-7's image-transfer utility can show thumbnails and large shots.*

These digital cameras have one thing in common: a 1.8-inch color LCD for through-the-lens previewing. For simplicity, the Fujix DS-7 steals the show; just aim it and click the shutter release. If you need to control every aspect of digital photography, the Ricoh RDC-2 makes more sense. But for the best image quality and price/performance ratio, the Olympus D-300L is our choice.

Fuji Photo Film USA Inc.

Fujix DS-7

The Fujix DS-7, from Fuji Photo Film USA, is a modest but sophisticated automatic camera that gives the user just enough control.

Instead of using autofocus, the DS-7 has three settings: macro (3.5 to 5 inches), close up (1.5 to 3 feet), and distance (3 feet to infinity). Although the camera automatically selects the shutter speed, you must choose either an open (f2.2 for indoor/low lighting) or a nearly closed diaphragm (f8 for outdoor/bright light).

The DS-7's biggest weaknesses are the absence of a built-in flash and the lack of exposure compensation. But the DS-7 has built-in automatic white balance for setting the correct color.

A bonus is the DS-7's ability to time- and date-stamp images and number them from 1 to 30,000. These features are especially valuable if more than one person uses the camera.

Besides its 1.8-inch LCD viewfinder, the DS-7 has a video-out port for displaying images on a TV or for use with a video printer. The camera can be programmed for auto-playback and for the display of either one frame or nine frames at a time, and when in information mode it can show real-time full-motion video, still images, or text.

The DS-7 is the first digital camera to use Toshiba's 2MB SmartMedia storage card. Thinner than a credit card and the size of a matchbook, a SmartMedia card is smaller than a PC Card, but at $60 per megabyte SmartMedia cards are more expensive. Images are saved as JPEG files; they can be acquired by Windows 95 Explorer and opened by any image-editing program.

After a few minutes spent familiarizing ourselves with the DS-7, we were producing excellent snapshots. The icon-based controls are well positioned and easy to understand, and the camera feels comfortable in the hand. Focusing seems simple, but we found ourselves misjudging the focus on close-ups. The DS-7 uses square rather than rectangular pixels, which—combined with a glass Fujinon lens—produced crisp, sharp images. Although the images were small, exposures were accurate, and colors were consistently realistic and well saturated.

The DS-7 reduces the complexity of digital photography to a simple aim, click, and view.

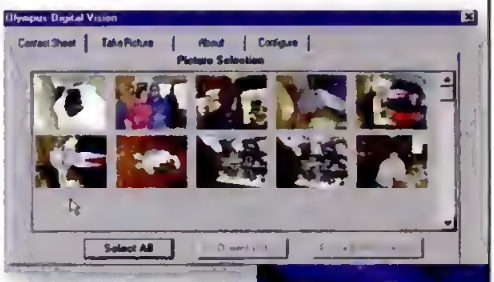
Fujix DS-7. Street price: $600. Requires: 8MB RAM, 10MB hard disk space; Microsoft Windows 3.1 or later; serial port or PC drive. Fuji Photo Film USA Inc., Elmsford, NY; 800-378-3854, 914-789-8100. *Circle 407 on reader service card.*

Olympus America

Olympus D-300L

At first glance, the small and stylish Olympus D-300L, from Olympus America, looks and feels much like a conventional 35-mm point-and-shoot camera, but it is a digital workhorse.

Getting started with the D-300L is easy: Just open the front flap to turn the camera on and expose the f2.8 autofocus wide-angle lens. Then press the large, silver shutter release to take a picture.



3-2-1 CONTACT: *The contact sheet for the Olympus D-300L can display a group of thumbnails.*

The optical viewfinder has cross hairs for centering the image and black frame lines for close-ups. You can use the LCD panel for more precise framing and positioning. The camera has five buttons and a control panel for adjusting image quality, flash, and flash mode, as well as for triggering the self-timer, locking the focus, and deleting the last frame.

The D-300L is one of the few digital cameras with red-eye reduction. About a second before exposure, the camera fires a series of rapid preflashes causing the subject's pupils to shrink. With 6MB of built-in RAM, the D-300L can hold from 30 to 120 images, depending on compression mode and images resolution (VGA or XGA); the camera has no removable memory system.

What makes the Olympus D-300L our choice is its superb

NINE LIVES: *From left to right, output samples of the Fujix DS-7, Ricoh RDC-2, and Olympus D-300L.*



PHOTOGRAPHY BY THOM O'CONNOR

image quality. At 1,024 by 768 pixels—the highest resolution of any entry-level digital camera—the D-300L's images have greater depth and detail than those of both the RDC-2 and the DS-7. And the D-300L can accurately record light and shadow over a range of seven f-stops, more than what most color film can do.

If you want nothing short of the best images for the money, the Olympus D-300L is for you. **Olympus D-300L.** Street price: $900. Requires: 16MB RAM, 40MB hard disk space; Microsoft Windows 3.1 or later; serial port. Olympus America Inc., Melville, NY; 800-622-6372, 516-844-5000; www.olympus.com. *Circle 408 on reader service card.*

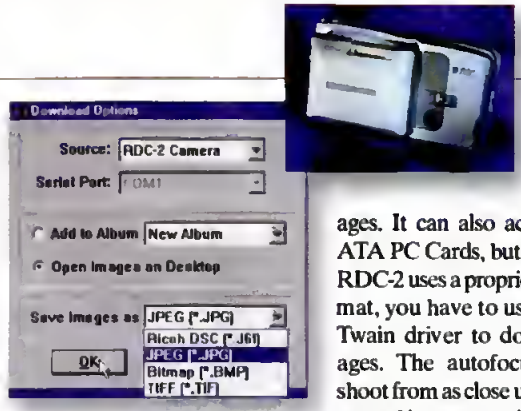
Ricoh Consumer Products

Ricoh RDC-2

The Ricoh RDC-2, from Ricoh Consumer Products, is as complicated as the Fujix DS-7 is simple. With the LCD viewer attached, the camera has a total of 19 buttons, knobs, and levers, plus a separate control panel, all of which adds up to an abundance of options, features, and controls.

Shooting with the RDC-2 involves shifting the on/off switch, selecting image quality with the Personal Intelligent Communicator, lining up the shot—on the 1.8-inch LCD panel or the optical viewfinder—flicking the wide-angle/ standard bifocal lens switch for correct framing, and pushing the shutter button.

There are several adjustable settings: picture quality, still images, audio only, audio with still images, continuous shooting—as fast as 1 frame per second and with or without audio commentary—and text mode. The camera can also be used for real-time videoconferencing, albeit at a slightly choppy 18 frames per second; Ricoh videoconferencing software is still under development.



ON THE FLY: *The Twain driver for the Ricoh RDC-2 can convert files to several popular formats.*

The RDC-2 comes with 2MB of RAM, enough for 9 high-, 18 standard-, and 36 economy-quality images. It can also accommodate ATA PC Cards, but because the RDC-2 uses a proprietary file format, you have to use the Ricoh Twain driver to download images. The autofocus lens can shoot from as close up as 10 inches, and images can be displayed on a TV set via a video-out port.

Unlike with the Fujix DS-7 and the Olympus D-300L, the RDC-2's $229 LCD viewfinder—including a speaker and volume control—is a snap-on option. Without the display, the camera is nearly slim enough to slip into a shirt pocket; with it, the RDC-2 can be unwieldy.

Operating the RDC-2 in other than single-frame mode was difficult. To move among the shooting modes, you have to memorize the commands. Icons are small, associated words or letters are hard to read, and button combinations are difficult to manage.

In its highest-quality mode, the RDC-2 produced sharp, high-contrast images that were visually pleasing, though the color balance was a bit on the cold side. Details tended to get lost in low light, but flash pictures were well exposed and exhibited excellent color balance.

The Ricoh RDC-2 produces plenty of picture-taking possibilities, but the price is complexity. **Ricoh RDC-2.** Street price: $1,000. Requires: 8MB RAM, 6MB hard disk space; Microsoft Windows 3.1 or later; serial port or PC drive. Ricoh Consumer Products Group, Sparks, NV; 800-225-1899, 702-352-1600; www.ricohcpg.com. *Circle 409 on reader service card.*

IMAGE EDITING

Pixel Power

Less is more with Picture It!—By Luisa Simone

Instead of emphasizing the customizable power tools found in high-level bitmapped graphics programs, Microsoft Picture It! provides a one-size-fits-all approach for $80 that should be more than enough for small-business or personal use.

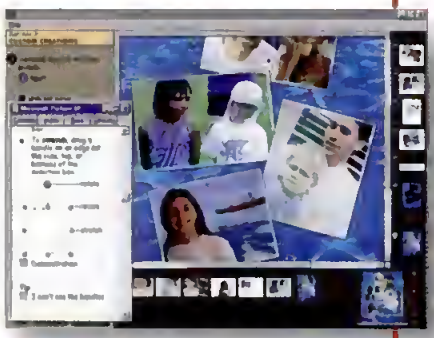
Picture It!'s streamlined interface gets high marks for making complex image-editing functions accessible to novices. In lieu of a complex toolbar, the program has six descriptive buttons, which provide access to a menu of basic photo-editing, design, and output options.

Two helpful features of Picture It!'s interface are Filmstrip, for storing multiple images, and the Stack, which organizes thumbnails of elements vertically. Rearranging layering order is simple: You grab a thumbnail and drag it up or down in the Stack.

Picture It!'s tools work well: Smart Selection, for example, lets you click at key positions along an object's edge. And instructions walk you through the process of modifying or correcting selection areas.

But the toolset is small. It provides the essential tools for correcting common photographic problems (red eye, color casts, and blurry focus) and collaging pictures. If you want painting tools or special-effects filters, you have to look to such entry-level programs as Adobe PhotoDeluxe and Fractal Design Dabbler.

Picture It! focuses on three types of projects: cards, calendars, and collages. But the program's most exciting aspects are its input and output capabilities. In addition to using images from digital cameras and scanners, and such standard file formats as JPEG and TIFF, users can have conventional film developed using the Kodak Image Magic System.



INSTA-SHOT: *Kodak Custom Creation templates allow you to pop your photos from the storage area along the bottom of the screen into a ready-made collage.*

In addition to outputting to color printers, digital slides, and the standard file formats, users can transmit completed projects to Kodak's Web site (*www.kodak.com*) and order high-quality photographs at reasonable prices.

Microsoft Picture It! List price: $80. Requires: 16MB RAM, 50MB hard disk space, Microsoft Windows 95. Microsoft Corp., Redmond, WA; 206-882-8080; www.microsoft.com. *Circle 406 on reader service card.*



UTILITIES

Divvying Up Disks

One-stop partitioning utilities help to streamline today's huge hard disks.—By Neil J. Rubenking

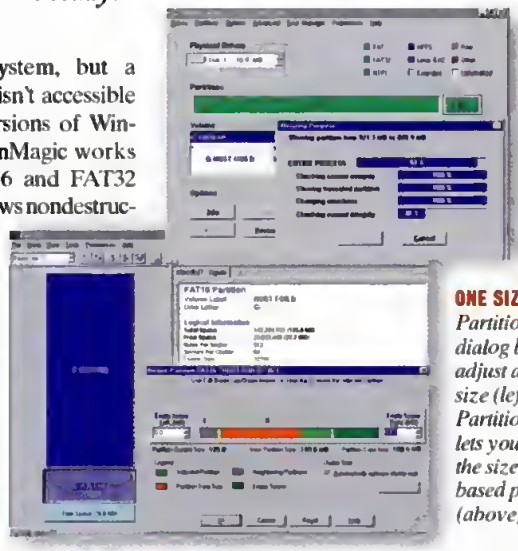
Hard disks get larger and larger, prices get lower and lower, but the file allocation table (FAT) system refuses to die. Two of the latest disk-partitioning packages—Quarterdeck Corp.'s $50 Partition-It and PowerQuest Corp.'s $69.95 PartitionMagic 3.02—let you create, delete, resize, and move FAT-based partitions.

To make efficient use of disk space and allow the use of multiple file systems on a single PC, large disks need to be partitioned. In a FAT system used by DOS, Microsoft Windows 3.*x*, or Windows 95, disk space for each file is allocated in clusters. The bigger the partition, the bigger the cluster and the greater the space wasted. A 1.6GB disk can waste hundreds of megabytes, but dividing it into two 800MB partitions cuts the cluster size and waste by half.

The newest PCs come with the 32-bit FAT32 system, but a FAT32 partition isn't accessible under earlier versions of Windows 95. PartitionMagic works with both FAT16 and FAT32 partitions and allows nondestructive conversion between them; Partition-It's FAT32 wasn't ready for testing.

NTFS and HPFS (used by Windows NT and OS/2, respectively) are substantial improvements over the FAT system. PartitionMagic is unique in its ability to create, format, and resize these partitions. It also offers a one-way nondestructive conversion from FAT to HPFS; Partition-It doesn't.

Partition-It is a native Windows 95 application. (A Windows 3.*x* version should be available by the time you read this.) For critical operations, however, Partition-It drops to DOS and restarts Windows 95 when finished. By contrast, PartitionMagic looks like a Windows 95 application, but it actually runs in DOS mode; PartitionMagic also runs under Windows 3.*x*, OS/2, and DOS.



ONE SIZE FITS ALL: *Partition-It's dialog box lets you adjust a partition's size (left). PartitionMagic lets you control the size of a FAT-based partition (above).*

Both utilities update system references when, for example, D: drive becomes E: drive, but Partition-It does so automatically. Both products can also move applications from one partition to another and adjust all pertinent system-file references.

Partition-It's true Windows interface gives it a slight edge in ease of use, but if you need support for NTFS or HPFS partitions or need a utility that runs under DOS or OS/2, get PartitionMagic.

Partition-It 1.0. Street price: $50. Requires: 8MB RAM, 6MB hard disk space, Microsoft Windows 3.*x* or Windows 95. Quarterdeck Corp., Marina del Rey, CA; 800-683-6696; fax, 813-523-2391; www.quarterdeck.com. *Circle 410 on reader service card.*

PartitionMagic 3.02. List price: $69.95. Requires: 8MB RAM, 8MB hard disk space, Microsoft Windows 95, or OS/2 2.1 or later, or DOS 5.0. PowerQuest Corp., Orem, UT; 800-379-2566; fax, 801-226-8941; www.powerquest.com. *Circle 411 on reader service card.*

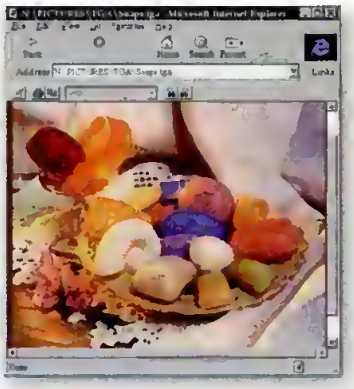
UTILITIES

Web with a View

INSO's QuickView Plus focuses on the Internet, with improved formatting capabilities.—By Barry Simon

Version 4.0 of INSO Corp.'s $59 QuickView Plus picks up where the last version of this Editors' Choice–winning file viewer for Microsoft Windows 95 and Windows NT 4.0 systems left off ("The Ultimate Utility Guide," May 14, 1996). You can still right-click on a file-menu choice to view a file, but there are three new viewing methods.

Quick View Plus (QVP) can now be installed as an ActiveX control that automatically views file types not otherwise supported by Microsoft's Internet Explorer. There's also a Netscape Plug-In that serves a similar function under Navigator. In addition, with QVP you can right-click on an attachment in Lotus Notes 4.0 and Microsoft Exchange and view the attachment. Finally, the program can reside in the Windows 95 taskbar tray and bring up a browse dialog box for direct viewing.



INSTAVIEW: *INSO's QuickView Plus lets you view files in Internet Explorer.*

The program supports over 200 file types, including the most popular word processing, database, spreadsheet, and graphics formats. Still, some old fallbacks have been omitted or are awkward to use. For example, among vector formats, WordPerfect .WPG and .WMF files are supported, but .EPS and CorelDraw files are only viewable if they have TIFF headers. The most significant omission is support for Access, TeX (.DVI) files, and Microsoft Office 97 file formats. INSO expects to update QVP on its Web site.

You can now view embedded graphs, and there's added formatting support for colored text, hyperlinks, headers, footers, and bullets. You can also see a full page at one time, and the Quick Print feature, which allows you to print a file without viewing, is a valuable time saver.

With its near-complete integration with Windows 95 Explorer and Web browsers, QuickView Plus was a pleasure to use. Any user looking for file-viewing capability will want QuickView Plus, and current users will want to upgrade.

QuickView Plus 4.0. List price: $59. Requires: 4MB RAM, 7MB hard disk space, Microsoft Windows 95 or Windows NT 4.0. INSO Corp., Chicago; 800-333-1395, 312-329-0700; www.inso.com. *Circle 401 on reader service card.*



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The LINE SPEED lie

Modem users are discovering hardware can make a difference in mobile connections.



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WEB UTILITIES

The Web: Fast and Slow

Net.Jet promises fast relief for Internet bottlenecks, but it's a mixed bag.—By David Haskin

Peak Technologies' $29.95 Net.Jet 1.11 speeds up Web page access, but if the page you want is frequently updated, the information you get may be a little out-of-date.

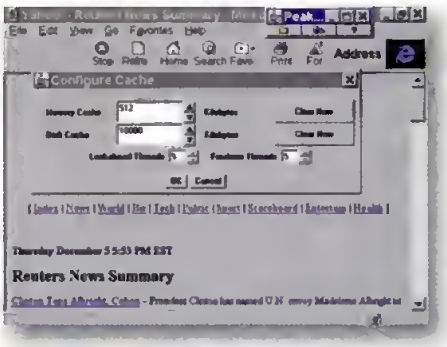
Net.Jet has little interface of its own. Rather, this 32-bit Java-based utility replaces your Web browser's cache and stores previously visited Web pages on your hard disk. A site loads faster from your PC's hard disk than it does over a normal Internet connection.

Net.Jet's secret is that it uses idle connection time to update Web pages in the background. The problem is that Net.Jet works only with text; it doesn't download images any faster than your browser can.

Net.Jet also monitors your browsing habits and periodically updates cached pages of frequently visited sites. With Net.Jet, all the text on the ZD Net home page required only 5 seconds to load—typical of the times we recorded during testing; using our browser's regular cache required 8 seconds. When we clicked on a link in one page, Net.Jet frequently loaded the linked page almost instantaneously. We tested Net .Jet with a 28.8-Kbps dial-up connection using Microsoft Internet Explorer.

Although Net.Jet 1.11 speeds up Web page delivery, this initial release works poorly with such frequently visited, continually updated sites as news and chat pages. Unlike your browser, Net.Jet doesn't compare cached and online versions; if it did, much of Net.Jet's time-saving advantage would be lost.

Instead, Net.Jet always displays the cached version. If Net.Jet happens to have updated the page in the last few minutes, you see recent information. But if Net.Jet cached the pages two or three hours ago, the information is outdated—at least by Web standards. Clicking on your browser's Refresh button has no effect when Net.Jet is running. A Peak Technologies representative told us that a version that caches pages more frequently and includes a manual update button should be available by the time you read this.



FACELESS: *Net.Jet replaces your browser's cache but has virtually no interface of its own.*

You can download a free, fully functioning evaluation copy of Net.Jet from the company's Web site; after it's installed Net.Jet automatically updates itself when Peak posts new versions. Net.Jet's initial release shows flashes of brilliance, but too often it serves only to speed up access to old information.

Net.Jet 1.11. List price: $29.95. Requires: 8MB RAM, 3MB hard disk space, Microsoft Windows 95 or Windows NT. Peak Technologies Inc., Bellingham, WA; 800-453-5322, 360-733-6010; www .peak-media.com/. *Circle 404 on reader service card.*

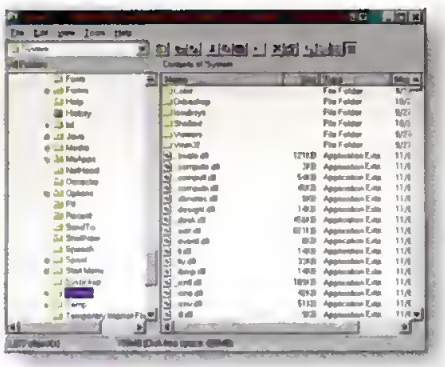
WEB UTILITIES

Web News While You Work

HeadLiner goes to the source in order to deliver news and information to your PC.—By Jon Kaufthal

Lanacom's HeadLiner delivers exactly the news you want, the way you want it. Like PointCast Network, HeadLiner is a free, Web-based service; but unlike PCN, HeadLiner ventures out into uncharted territory to get your news.

Based on software-agent technology, HeadLiner combs the Web for news, weather, stock quotes, and more. Instead of using a proprietary system, HeadLiner goes directly to your favorite Web sites and pulls content straight from the pages.



EXTRA, EXTRA: *HeadLiner brings you all your news the way you like to see it.*

Using separate profiles—or content agents—for each Web site, HeadLiner identifies the site's headlines and story links. The service then brings the data directly to your PC.

Getting started is a breeze: A setup wizard asks a few questions about your location and interests, and then suggests several Web sites. You can modify this list by choosing as many as 40 sites via a simple checklist. HeadLiner can either check for news when you connect to the Internet or dial up on its own; the program also checks newsgroups and e-mail. Automatic daily check-ins with Lanacom's server ensure that you get software updates and profiles for new and modified sites.

To suit different tastes, HeadLiner provides several delivery routes. There's a flashy screen saver—similar to PCN's—and a news ticker that scrolls across the top of your screen. Our favorite feature was NewsTitle, which puts the latest headlines in the title bar of the active application, conserving valuable screen real estate; click on a NewsTitle headline and your Web browser displays the full story.

HeadLiner's Manager lets you tweak settings and view archived news; filters and alerts put you in control of which headlines you see. News is sorted by day and by site on one side of the program's interface; a panel on the other side shows the full story.

A free beta release of HeadLiner is currently available from Lanacom's Web site. In addition, a Plus Package, featuring enhanced capabilities, is scheduled for sale later this year. This add-on includes intranet support as well as the ability to subscribe to an unlimited number of sites and create your own agents.

In short, HeadLiner provides all the news that's fit to download.

HeadLiner. List price: Free. Requires: 8MB RAM, 3MB hard disk space, Microsoft Windows 95 or Windows NT with Dial-Up Networking. Lanacom Inc., Toronto, Ontario, Canada; 416-490-7744; www.lanacom.com. *Circle 405 on reader service card.*



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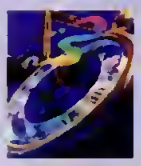
Only Graphics Suite 2 delivers everything you need to meet the needs of your entire organization. **Micrografx FlowCharter 7.** Windows Sources* says, "FlowCharter has more powerful features and greater ease of use than other flowcharting and diagramming tools." In fact, it's the most productive diagramming tool available.


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First Looks

MATH SOFTWARE

The PC Is Now Axiomatic

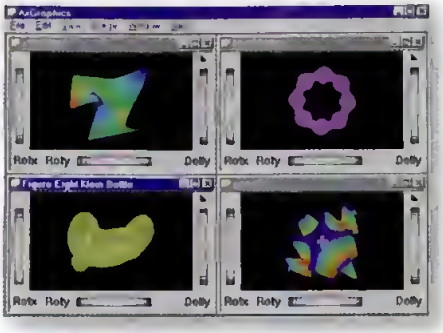
Sophisticated mathematical software comes to Windows.—By Barry Simon

Numerical Algorithms Group's $750 Axiom is the program for those with extremely sophisticated mathematical needs, but it may be too complicated for solving simple problems.

Like Mathematica, Maple V, and Macsyma, Axiom can either be run in interactive mode or work with programs written in its proprietary symbolic-math language. And like its competitors, Axiom deals with symbolic manipulation, arbitrary precision real numbers, and exact rational arithmetic. But Axiom goes a step further by including a compiler to improve performance.

What sets Axiom apart is its extensive variable typing and the program's object-oriented hierarchy of methods. For example, we set up a type (the assignment of variables to classes): List Equation Polynomial Fraction Integer, which describes lists of polynomial equations whose coefficients are rational. This level of typing detail would be oppressive but for Axiom's ability to infer the type of any object that you don't explicitly set. These types form a hierarchy of methods that act on objects in an inherited fashion, much as they do with object-oriented programming.

The program lacks its competitors' large libraries of rules for such items as simplification of trigonometric formulas. You can use Axiom to do such simplifications, but only if you tell it the rules; so Axiom is ill-suited for certain simple problems.



SPIN CYCLE: *Axiom's high quality 3-D graphics can be rotated in real time.*

Three-dimensional graphs appear in a window with a wheel so you can rotate and zoom in on the results in real time. And links to NAG's Libraries of FORTRAN routines and to IRIS Explorer, the company's scientific visualization program, are a bonus.

Axiom's user interface is IBM's TechExplorer, which allows integration of an extensive help engine with TeX-based displays of formulas. This works well for simple interactions, but the program lacks the visual nature of the notebook interface that Mathematica pioneered. The result is that with Axiom you can't mix text with formulas.

During testing, Axiom was prone to crashes, particularly while accessing 3-D graphs, and rather than storing program data and settings in the Registry, Axiom requires long strings in your AUTOEXEC.BAT file.

Axiom is late to the PC symbolic-math party, but it's a serious contender worthy of evaluation.

Axiom. List price: $750. Requires: 24MB RAM, 70MB hard disk space; Microsoft Windows 95 or Windows NT. Numerical Algorithms Group Inc., Downers Grove, IL; 630-971-2337; fax, 630-971-2706; www.nag.com. *Circle 416 on reader service card*

OS/2 UTILITIES

The OS/2 Tune-Up

Performance Plus finds extra processing power. —By Brian Proffit

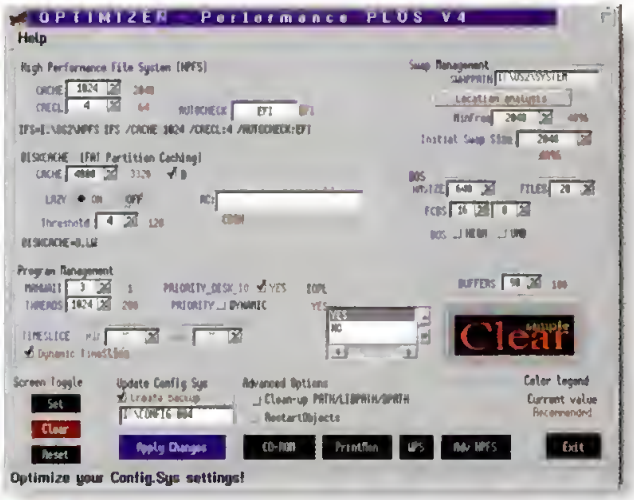
Clear & Simple's $40 Performance Plus 4.0 is a rich set of tools—and a bargain—that lets you tune your O/S2 system for maximum performance.

The manual that comes with Performance Plus is more a primer on OS/2 tuning than a typical user's guide. Of the 114 pages, 90 discuss the factors that affect performance and tell you how to optimize performance, so the manual is far more valuable than most product documentation. It even discusses the new option in OS/2 Warp 4 that lets you terminate individual processes in your system.

Following the instructions, we first ran the included benchmark program, which records performance in four areas: program loading, CPU, disk, and video. We then ran Performance Plus Optimizer, an intelligent front end to the CONFIG.SYS file. After accepting all of Optimizer's recommended changes, we repeated the benchmark program. Our system's ability to load programs improved by 13 percent, while disk access time and video speed improved by 4 percent and 11 percent, respectively.

Performance Plus accomplishes these improvements primarily by optimizing the cache and buffer sizes. We could probably have achieved these results manually, but it's hard to imagine an easier, quicker way to get such performance gains.

The program's BlackBox provides an intelligent front end that simplifies changing DOS and Microsoft Windows program settings to improve their performance. In addition, Performance Plus comes with a Lite version of Clear & Simple's file manager, DiskJockey, JukeBox for quick, low-overhead playing of sound files, a simple, quick bitmap viewer, an automatic desktop archive facility, and a backup program that uses the freeware compression utility, InfoZip.



GETTING BETTER: *Performance Plus Optimizer provides a graphical front-end to the CONFIG.SYS file and recommends improvements.*

At $40, Performance Plus is a bargain that can help you get the most out of OS/2.

Performance Plus 4.0. List price: $40. Requires: 8MB RAM, 3MB hard disk space, OS/2 Warp 4. Clear & Simple Inc., Simsbury, CT; 860-658-1204; fax, 860-651-0354; www.clear-simple.com. *Circle 415 on reader service card.*



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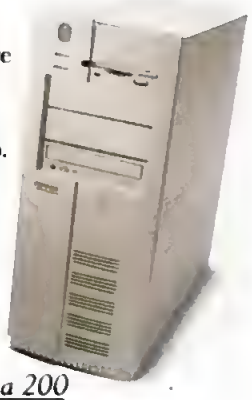
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The ProSignia 200

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First Looks

UTILITIES

Who's Doing What When

Interested in a key-by-key account of how employees use their PCs? Try WinWhatWhere.—By Neil Rubenking

WinWhatWhere 97 keeps a detailed record of activity of one PC or every PC on your company's network. This $99 package can track how much time an employee spends using a program, working on a document, or visiting a Web site, and it can count the number of keystrokes and mouse clicks, and measure the distance a mouse has moved. Although this monitoring of computer time and usage may seem intrusive to some, WinWhatWhere (W3) can provide valuable productivity and ergonomic information.

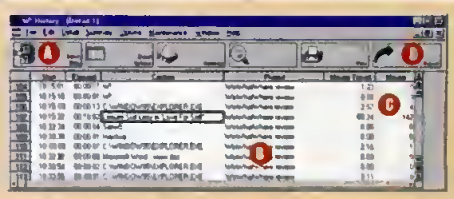
W3 works by automatically updating a central database with detailed reports from all W3-equipped workstations on a network; it then lets you export the collected data in a variety of formats. The program not only tracks which applications are active, but it reports changes to an active window's caption to capture the name of the document in use or the Web site visited.

The administrator can set W3 to run invisibly and prevent its being turned off. Despite its potential for abuse, W3 need not be a tool of oppression. A report that all workstations are busy 95 percent of the time, for example, may indicate the need to buy more or better equipment. And W3 can be used to perform time and motion studies, so that software designers can quantify and minimize mouse mileage and keystrokes. Contractors can use the program to generate time and billing reports.

The program is available for a 30-day free trial from the company's Web site. With WinWhatWhere, you'll know how your PCs are being used.

WinWhetWhere 97. List price: $99; network version, $495. Requires: 8MB RAM, 5MB hard disk space, Microsoft Windows 3.*x*, Windows 95, or Windows NT 3.51 or later. WinWhatWhere Corp., Kennewick, WA; 800-242-4775; fax, 509-585-9294; www.winwhatwhere.com. *Circle 402 on reader service card.*

WAZZUP? *WinWhatWhere reveals exactly how a PC is used*



A. The information is organized in a familiar file tree, main controls are on the top. Time spent performing a task is listed, as is the program being used.
B. You can assign a billing code or project name to any activity.
C. The program tracks the number of times and how far a mouse moves.
D. W3 provides an extensive collection of export options for producing activity reports.

PRESENTATION SOFTWARE

A More Persuasive Web

With its new interface, Adobe Persuasion becomes a better corporate citizen.—By Wayne Kawamoto

Adobe is turning its $395 Persuasion presentation package into a better corporate citizen. Persuasion 4.0 includes high-level file compatibility with Adobe Photoshop and Adobe Illustrator—making its interface more consistent with other Adobe products—and this version adds the ability to convert presentations into Web-based documents.

To support use of the Internet, Persuasion now includes a copy of Adobe Acrobat Distiller, which provides a conversion utility for putting presentations into Adobe's portable document format (.PDF). Users can download .PDF files of presentations and view them either with Adobe Acrobat Reader—which is distributed free—or with Netscape Navigator or Microsoft Internet Explorer in much the same way as they view conventional HTML pages.

Building on its Web features, Persuasion can now link presentations with any site if you drag and drop a URL from your browser into the program. In addition, Persuasion offers customizable templates for creating Web documents. A link-management feature tracks links with pages, graphics, and URLs.



WEBSTER: *Adobe Persuasion pages can now be converted for use on the Web.*

To work with other Adobe products better, Persuasion now accepts images directly from Photoshop and Illustrator. Our tests showed that within Persuasion Illustrator files become bitmap images that retain their original PostScript information, and Photoshop images retain their layers.

Longtime Persuasion users will notice that not only does the program's interface now resemble that of other Adobe products, but the program supports similar keyboard shortcuts as well.

Other features improve on Persuasion's general capabilities. A new eyedropper is a standard graphics tool that lets you sample, identify, and match colors from imported graphics or from anywhere on the desktop. You can manipulate images with a new cropping tool, and pixel-based nudge tools help you to position and size text or graphic objects exactly.

In addition, Persuasion now has 84 different chart types, including some very pleasing 3-D varieties. By letting you simply drag and drop multimedia elements and graphics from other applications, the program accepts them in up to 30 independent layers. There's even a conversion program for importing Microsoft PowerPoint presentations into Persuasion.

In all, Adobe strengthens Persuasion's ties to its fellow Adobe products, increases the product's capabilities, and adds .PDF-based Web support. It's not quite your mainstream presentation mix, but Adobe Persuasion 4.0 handily performs most jobs that require a persuasive look.

Adobe Persuasion 4.0. List price: $395; upgrade, $129. Requires: 8MB RAM, 20MB hard disk space, Microsoft Windows 3.1 or Windows 95. Adobe Systems Inc., San Jose, CA; 800-685-3505; fax, 408-537-6000; www.adobe.com. *Circle 403 on reader service card.*

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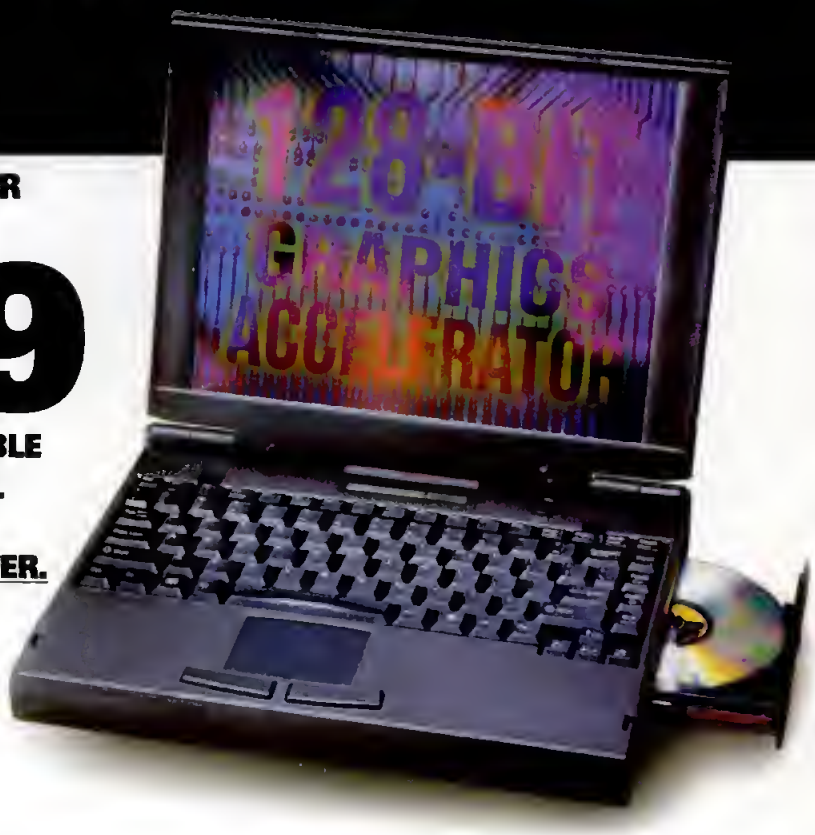
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"The U.S. Robotics Sportster ISDN 128K stood out for its performance, ease of use, all-around flexibility, and reasonable price... it blew away the competition in our remote access tests, making it an ideal choice for telecommuters. The Sportster was a dream to install—you simply plug it in and go." PC World, August '96

"The Sportster ISDN 128K might have been named the Screamer. It was the only product in our test group to provide data compression, and this ISA-bus ISDN adapter, from U.S. Robotics, blew the other five products away on our performance tests." PC Magazine, June '96

"A top performer in our testing, the inexpensive, feature-rich Sportster 128K has 'buy me' written all over it... At only $399, this internal adapter rockets you from place to place on the Internet at speeds of over 113 Kbps with none of the limitations imposed by a serial port." CNET, July '96

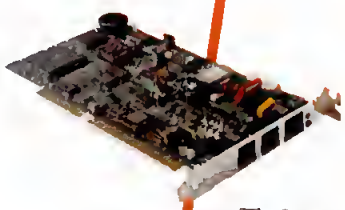
Let's just say light is starting to get jealous.

It's not surprising, considering the Sportster's features: TurboPPP™ provides compression up to 512 Kbps. The onboard analog port lets you connect a standard phone or fax, allowing you to talk or send/receive a fax simultaneously with data transmission.

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Second Looks

NOTEBOOKS

The Open Door Policy

The Panasonic CF-25 earned our kudos for merging the durability of a ruggedized design with the performance and portability of a value notebook (First Looks, January 21, 1997). During our evaluation, the CF-25's metal case took the knocks of daily use and came back for more.

After we published our review, we discovered a part of the case that didn't quite stand up to our punishment. Although virtually the entire case is made of a high-strength magnesium alloy, the hinged latches that conceal the floppy disk drive, PC Card slots, and ports on our unit were constructed from fiber-reinforced plastic. As happens so often with notebooks, it didn't take long before a latch broke off, leaving the floppy disk drive exposed to the elements.



We were not alone in discovering this, because Panasonic—and some early buyers—also noticed the problem. Panasonic engineers redesigned the latches using a stronger and slightly thicker plastic, particularly for the area around the thin hinge pins that hold the door in place. The hinges were also redesigned, so they snap in and out more easily, minimizing the chances of breaking the part altogether.

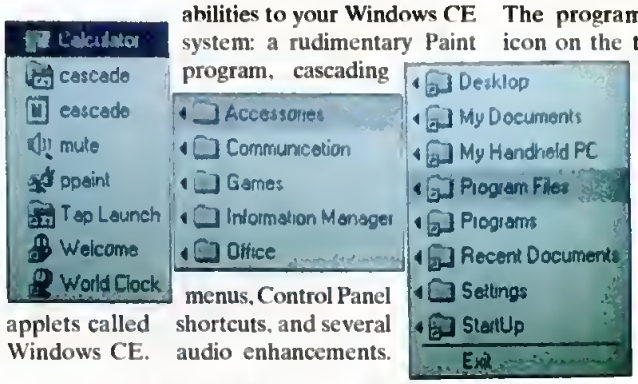
For details on how to get replacement doors for your CF-25, call Panasonic at 800-662-3537.

With its revamped doors, the Panasonic CF-25 should be a sturdy and reliable travel companion.

UTILITIES

PowerToys, Writ Small

Even the most die-hard Windows CE fans would admit that Microsoft's operating system for hand-held PCs lacks many of the functions, tools, and grace of a desktop operating system (First Looks, January 7 and January 21, 1997). Realizing that, Microsoft is bolstering Windows CE with some interesting add-ons, starting with a group of utilities and applets called PowerToys for Windows CE.



Unlike the PowerToys for Windows 95 (First Looks, October 24, 1995), this group of programs is strictly business. Free for download from *www.microsoft.com*, the 1.2MB PowerToys file adds four major abilities to your Windows CE system: a rudimentary Paint program, cascading menus, Control Panel shortcuts, and several audio enhancements.

Load POWTOY.EXE on your desktop PC with your Windows CE system connected and the installation program does the rest. Plan to spend about five minutes getting PowerToys set up.

In addition to three groups of new sounds (analog, metallic, and organic), PowerToys adds the ability to mute the system at the touch of the stylus. The program has a speaker icon on the taskbar tray that can instantly quiet your Windows CE machine. Tap on it and a black X covers the speaker icon, signifying that the unit is in silent running.

On a day-to-day basis, the most useful part of the PowerToys collection is the Control Panel Annunciators, which reside in the taskbar tray and consist of nothing more than shortcuts to frequently used Control Panel details. PowerToys also adds the ability to cascade menus, streamlining the use of these hand-held PCs. This feature works from a taskbar tray as well and looks like a folder with a file icon on top. Tap that icon and a list of the system's major functions—which is different from the Start menu—appears on the right. Each of the items, from Desktop to Settings, can be cascaded to the left, making it easy to get to all of your HPC's functions.

The lack of the Pocket Paint program was probably the most significant deficiency of the original Windows CE release. But the Pocket Paint program in PowerToys has a major shortcoming: It's strictly monochrome. Colorful bitmapped images are rendered in posterized gray-scale. And the applet is limited to .BMPs, which makes it poorly suited for viewing graphics files. In the final analysis, we found that Pocket Paint was better for creating hand-drawn images, such as maps, notes, or rough floor plans, that will be faxed or e-mailed from your ultraportable PC.



In sum, PowerToys makes a Windows CE system handier.

SECOND LOOKS MAILBOX: Tell Second Looks about your experiences with computer products. Contact Brian Nadel via MCI Mail (556-1500), CompuServe (72241,1616), or the Internet (bnadel@zd.com).

BUG BRIEFS

Problem: Our mailbag has been filled with letters from users of IBM AntiVirus 2.5 looking for a simple, quick, and direct way to remove the entire program.

Solution: *Unfortunately, in order to remove all vestiges of AntiVirus from your PC, you must go through a convoluted 20-step process that's detailed in the program's Help section.*

Problem: The 3-D performance of the Editors' Choice–winning Diamond Multimedia Stealth 2000XL paled in comparison with its excellent 2-D abilities.

Solution: *To speed things up considerably, download and install the latest drivers from Diamond's Web site (www.diamondmm.com).*

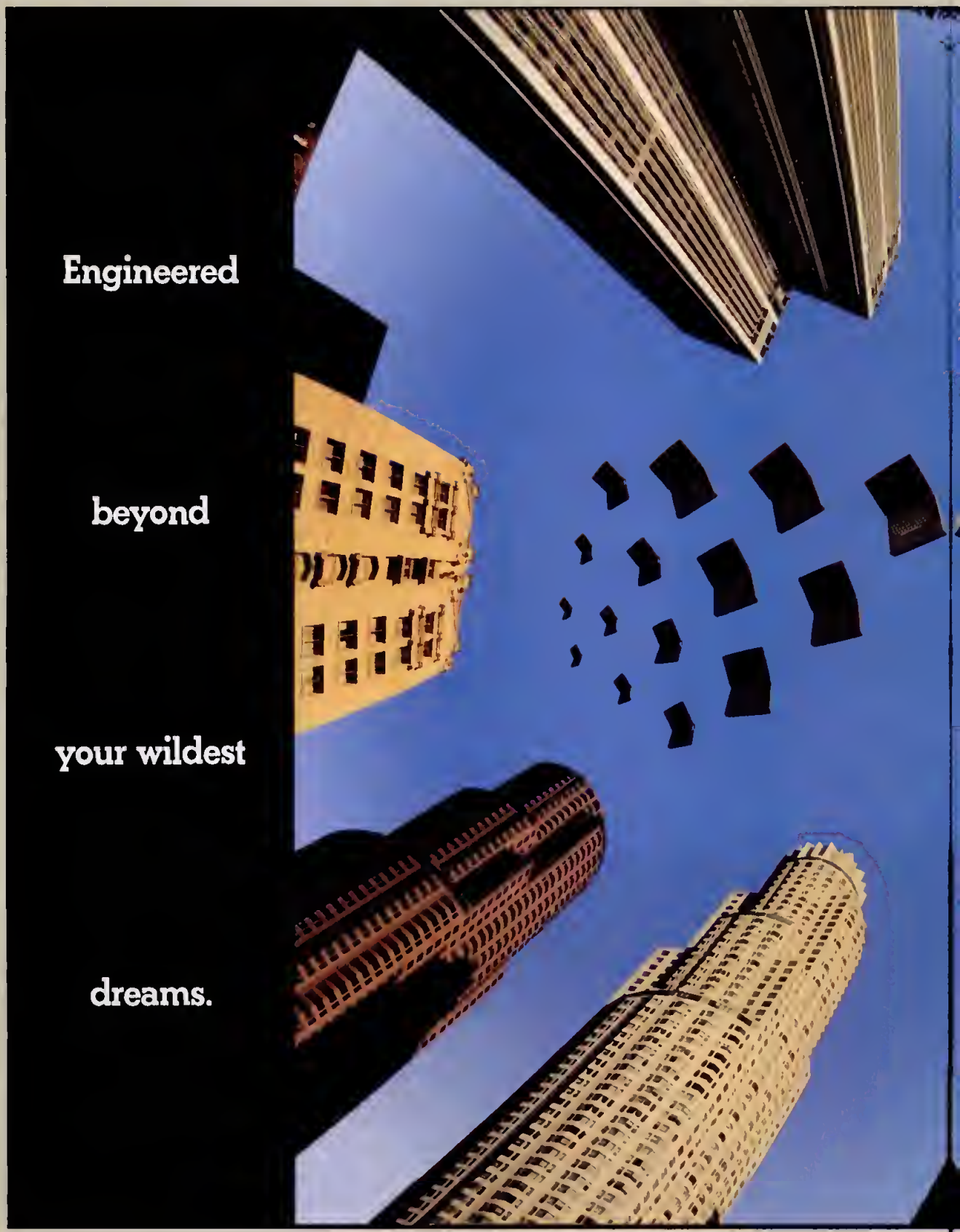
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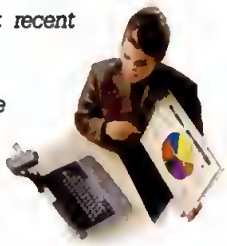


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BILL MACHRONE

Getting into a Higher Gear

The mere fact that you're sitting here reading this magazine means you care about your future. You wouldn't expend this much effort on anything that you didn't care deeply about or that wasn't important to your career. You're learning new things all the time. The challenge is to learn the right new things so you can stay on top of emerging technologies and make informed decisions about products and projects.

PC Magazine Labs technical director Nick Stam and I were talking recently, trying to identify the technologies and areas of knowledge that will propel you and your career into the next century. Here's a rundown of some of the things we consider most important.

HTML is almost too obvious to list. Although we'll evolve to a time when people say, "Remember when we used to hand-code these pages?", we aren't there yet, and we won't be for several years. Great-looking pages need to be tuned and tweaked. Whether you're doing it yourself or supervising the effort, HTML will affect your life for some time to come. Making those pages do what you want on the server side is a job for CGI, JavaScript, and Perl. Too many server scripts hurt performance, but there's an inescapable bare minimum of them.

For developers, C++ is the language of choice, although I'm not entirely sure why. I don't program anymore, but from my vantage point it looks as though programs written in object-oriented C are as incomprehensible as everything else that's ever been written—they're just bigger and slower. For my money, you can get a lot more done in Borland's Delphi.

C++ will put you closer to the heart of Java, however. The world of thin clients and portable applications is far from sorted out, but Java will doubtlessly play a key role. As a developer, you may be frustrated by Java's limitations, but they are there for your own (and the client's) good. It's equally important to understand ActiveX, because even though Microsoft will continue to support Java, it hopes to reduce Java's significance drastically through the sheer power and flexibility of its next-generation ActiveX controls.

You can get into ActiveX at any of several levels. At the most cursory, you'll just include it in your programs, setting switches to determine which features your users can and can't use. At the deepest level, you can get into the underlying object model. Learn all you can about ActiveX, because this new breed of controls is much more powerful and functional than anything you've seen before.

The Internet explosion is creating lots of new job opportunities (many of them unwelcome, especially in companies that were just getting their LANs to be stable). Now, as you look into load-balancing HTTP requests across multiple redundant servers, you'll find hardware and software, each with its own pros and cons. You'll also want to brush up on the latest in IP-address allocation. Here again, you'll need to sort out competing techniques and technologies, such as BOOTP, DHCP, and WINS.



STUDY GUIDE

Read up on the technologies that will propel you and your career into the next century.

In the database world, ODBC is well established, but JDBC is barking at its heels, and Microsoft Jet is, well, taking off. Databases and data warehouses are essential for building the next generation of Web sites for intranets and the Internet. Your future success won't be measured by how many pages your site contains but by how many can be built on the fly and how fast.

All of that back-end technology is worthless if people can't get to it. Building a high-speed network that handles all your internal and external traffic is an arduous task. The router and switch companies keep cranking out new hardware and promising faster speeds, but only careful study will help you select the right products and providers. You've got critical decisions to make about third parties and outsourcing, service providers, and telcos. Can those companies provide (or do you even want) remote LAN access? Security issues are paramount here, so you've got to steep yourself in the latest firewall and encryption technology, too. Is your site ready to process secure transactions? Do your customers agree?

From the user side, are you up to speed on everything you could be doing for your road warriors and telecommuters? What about audio- and videoconferencing? If you're still using POTS (plain-old telephone service) and fractional T1 solutions, you need to keep an eye open so you can judge when the ever-better Internet solutions are ready for prime time.

Whew. That's quite a to-do list. Good thing this is fun. □

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JOHN C. DVORAK

When Push Comes to Shove

It's called *push technology* or just plain *push,* and it's the latest buzzword in the Internet game. It's also something we don't need and should reject. Push technology assumes we need more information when we already have too much. The idea stems from the notion that we currently gather information from the Internet using *pull* methodology. In other words, we decide we want something, then we actively go out and get it. You'll find a similar concept in sales and marketing. For example, a customer goes into a store and asks for a particular product. If the store doesn't have it, the manager orders it. Eventually, the store stocks that item.

The converse is push-through marketing, in which the store carries and sells to customers products they didn't know they wanted to buy. Merchandising and hard salesmanship convince us that we need some product or other. In many cases, push marketing results in customers buying things they don't want. Manufacturers prefer push-through marketing because it is controllable, and it's also the only way a crappy product can be sold. I think you might see where I'm headed with this. The key word is *crappy.*

On the Internet, the idea has emerged that instead of waiting for people to find your Web site or products, you push a Web site (or the information contained therein) at them. You get people to sign up for some service, such as a so-called customized newsletter, and then you flood them with material they never asked for. The idea of push is to move more information from point A to point B, whether point B wants it or not.

You might make the argument that we would want the information if we knew it existed. Again, this takes us back to marketing. Most real sales are in fact pull-through, whether marketers want to admit it or not. Nobody buys no-name detergent. We are convinced by advertising that Tide is the one to buy. We go seek Tide out and buy it. The ads *push* the customer to *pull.* The push is involved in the marketing, not in the product. Nobody delivers Tide to your doorstep whether you want it or not. Herein lies the problem with push technology on the Internet. We don't want more information; we want better information, on our own terms.

I learned this lesson years ago the hard way, while using the GEnie online service, which would provide you with a newsletter customized to your interests. I'm interested in computers. So I entered "computers" and "IBM"—just two words—on the form. What a mistake. I got every story and related story from numerous newsfeeds. I let my box go three days and thousands of messages piled up. I tried to get through them but couldn't. Soon, there were 8,000 items in my in-box clogging up everything. Before a month went by, I had to cancel the account and discard the whole in-box. In *PC Magazine,* every single article and ad is computer-related. Do you want them all? Go to the Web site yourself and pick what you want, or thumb through the magazine. That's pull. Having all of it shoved down your throat, that's push. Which do you think is better?



PUSHY WEB SITES

Picking what you want—that's pull. Having it shoved down your throat—that's push.

The fact is, we need a human between us and the flood of information. This person is called an editor. This editor works for a publication, usually with other editors. Together, they sift through information—most of it being useless—and they, as a team, pick what they think readers might be interested in. This gatekeeper function keeps us not ill-informed but properly informed.

These functions cannot be done by a computer anytime soon, no matter what people tell you. They require something a computer doesn't have: thought. Computers can be programmed to sort news stories to a small degree, but the real result in the long term will always be an inundation of information—most of it useless. But if the spigot is turned down too much, important info will be lost altogether.

I'm convinced that the push concept is just another farce, a scam, a cheap trick to sell more ads in new ways. I have nothing against advertisers. My limits are high. I've advocated placing advertisements over the urinals in bathrooms so that businesses can tempt a captive audience. But that's different from having my mailbox fill up with pushed-through information or having my browser download gigabytes of useless nonsense. I object to the notion that we should drown in information for the sole purpose of satisfying a desire to see exactly how far advertising will go before people say stop. When it comes to information, only the seeker is sure of what he or she is looking for. The entire push philosophy negates that simple concept.

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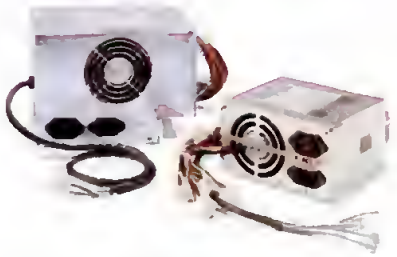
ULTRA-QUIET



Toss the earmuffs! The best way to get relief from a noisy computer is with a **Silencer®** power supply. Its high-efficiency fan reduces noise up to 90%! A *multimedia* must.

SILENCER 230 SLIM $69
SILENCER 235 ATX ..... NEW! $79
SILENCER 270 SLIM $119
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HIGH-PERFORMANCE



For power that won't skip a beat during hard drive access or line voltage sags, upgrade your PC with a premium **Turbo-Cool®** power supply. You'll get 50%-100% more power, built-in line conditioning, super-tight regulation, ultra-clean output, enhanced cooling, UL/CSA/TUV, and **3-5 year warranty!**

TURBO-COOL 200 SLIM $79
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TURBO-COOL 300 ATX ..... NEW! $129
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TURBO-COOL 400 ATX $219
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For a clean, easy-to-build system, get the **Personal Mini-Tower** enclosure. Features: (3) 5-1/4" bays, (4) 3-1/2" bays (2 int.), and a slide in/out motherboard cage.

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	Mini	Tower	Monster
Total Bays (Exposed Bays):	6(4)	10(8)	18(13)
MB and P.S. Capacity:	1	1	2

SOLID-STEEL MINI $169
SOLID-STEEL TOWER $279
SOLID-STEEL TOWER ATX $299
SOLID-STEEL MONSTER $789

REDUNDANT POWER



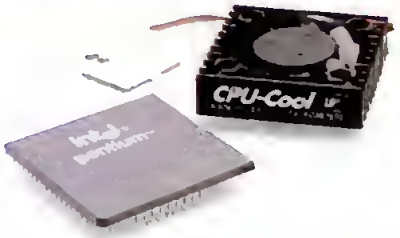
Get redundant 250W power, *in 1 slim unit*, with our economical **Two-in-One 500.**

For mission-critical reliability (5,000,000 hr. MTBF), choose from our *hot-swappable* **TwinPower™** series!

TWO-IN-ONE 500 ..... NEW! $229
TWIN-POWER 800 ATX ..... NEW! $819
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CPU COOLERS

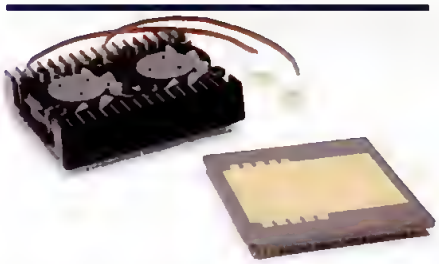
PENTIUM & 486



486s & Pentiums run hot, often exceeding 210°F! Cool'em by 90°-120°F with genuine, low-profile **CPU-Cool™** coolers. Each consists of a long-life, ball-bearing fan *integrated* into a patented, die-cast, 413 aluminum heat sink. Easily mounts on the CPU. Last 10X longer and are 40% thinner than cheap, bulky imitations! Made in USA. 5-year warranty.

CPU-COOL 1.9T (486, 75-133 P5) $21
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Check the specs for the best P6 thermal solutions!

	Snk/Aux. Fan	Std. Cooler	CPU-Cool 3.2	Dual CPU-Cool
Thermal Resist:	1.5°C/W	1°C/W	0.8°C/W	0.6°C/W
3-Yr. Fail Rate:	1:100	1:10	1:1,000	1:1,000,000
Height:	1.2"	1"	0.74"	0.74"

CPU-COOL 3.2 ..... $29
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Don't let a bad fan or a clogged filter cost you your system! Detect overheating, *before* damage occurs, with a **110 Alert™** 110°F heat alarm. Low-cost protection for any PC.

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JOHN C. DVORAK

Inside Track

Intel is just rolling out MMX, and we are already beginning to **hear rumblings about MMX2.** Oh, brother. I have no idea what MMX2 is supposed to be, but let's hope it doesn't add yet more instructions to the processor. I assume it's just some optimization.

Chip Technology Dept.: If you're looking for that cocktail-party buzzword du jour, try *extreme UV lithography.* This is the technology that will again **postpone the inevitable** change that will soon take place in basic chip-process technology, the change that all chip makers fear: the evolution from using light to using X rays to draw little lines in silicon. Once X rays have to be used, mask technology and everything else that can block light has to be changed. X rays go through everything. EUV lithography will supposedly take the line width on a chip down to 0.1 microns. Intel is expecting its **next-generation process** to produce chips using a .25-micron line size. Most state-of-the-art chips today are done at a .35-micron size.

The original presentation made it seem as though the NC was designed to take the place of the PC in every way. Once the concept was made clearer, I agreed that the NC could work for certain vertical applications.

I recall the days when there was a huge debate about whether achieving submicron sizes was going to be next-to-impossible. When someone first managed 0.8, it was a big deal. "Probably the limit forever!" Amazing, these guys.

Whatever Happened to Radio Shack as a Computer Giant, Anyway? Dept.: One of Tandy/Radio Shack Corp.'s major shareholders, Jesse Upchurch, was recently ousted from the board and began to **make a public fuss** about the long, slow decline of the company as a leader in technology. **Believe it or not,** Radio Shack was at one time the number-one retailer in computer electronics and held a **40 percent market share** in the personal computer business. That was in 1981, the year John Roach was brought in, and that was when the decline began, according to Upchurch. More recently, Tandy **shut down** its Incredible Universe megastores and decided to refocus Computer City—both of which are retail concepts credited to Roach.

When Tandy made the announcement about pulling the plug on Incredible Universe, I was disappointed, because I never managed to get to one of these stores to see it. It was supposed to have been spectacular. I've never even driven by one. Somewhere along the line, the three rules of retail success were lost on Tandy: **location, location, location.** From my perspective, these stores were out in the **middle of nowhere.** I'm sure management blamed the failure on something other than locale, but that was the real reason Incredible Universe flopped.

My experience with Computer City has not been much better. One time, I was invited to broadcast a radio show from one of the first Computer City stores. At the time, I had four or five books on the market. The store did not sell any of them—what I would have expected as a minimum courtesy. When I asked the store managers about this oversight, they admitted they didn't know much about computers. Upchurch may be on to something with his complaints.

Subversive Activity Dept.: What the heck is Lotus up to with its plans to promote a **rent-an-application** scheme? The local papers around Boston have made some vague references to the idea. This is part of that new Domino system you see in ads on TV—*confusing* ads, I might mention. Domino is actually a **Web application server** designed to do a number of things, including incorporate Lotus Notes into the Web environment. Along with this comes some sort of scheme to rent applications. According to reports, ISPs are somehow going to make money on this deal. We'll see how this develops.

We Get Letters Dept.: From Mohamed Samy, I received this terse note: *Why did you change your opinion about the network computer in* PC Magazine*? You first said it was a failure ("turkey of the decade"), then you said that the smart company that invents a cheap Web surfer could eat off the Wintel platform. Which opinion should I believe?*

I normally don't think it's necessary to explain a change of heart, but I will this time. The original presentation of the network computer made it seem as though the NC was designed to take the place of the PC in every way. Once the concept was made clearer, I agreed the NC could work for certain vertical applications. I think the NC has potential. **Always take the second opinion.**

Weird-Site-of-the-Month Dept.: This is a new Inside Track Department. I seem to run into odd Web sites naturally in my online travels. Try this one on for size the next time you go surfing: *www.infowar.com.* This is a site dedicated to following serious **security problems,** high-level hacks, information warfare, espionage, and the like. Very interesting indeed. Webmasters and IS managers should bookmark it.

So What Gives with the Mac Community? Dept.: Still convinced that Apple is going to launch a PC clone, I was amused by a recent trade journal survey that discussed **Macintosh-user desires.** What did they want most in a new "modern OS"? Number one on the hit parade was plug-and-play hardware support. Sounds familiar, huh? Protected memory, native PowerPC code, and preemptive multitasking were next on the list. Except for native PowerPC code, this sounded like a laundry list from a Microsoft Windows or OS/2 user. Since when did the tail wag the dog? Second to last on the Mac list was built-in Java support. Mac users will want that, too, once it becomes popular on the PC. Times sure do change. □

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However, NEC computers lower the total cost of ownership in other ways as well. Take Versa® notebooks, for instance. Not only is the NEC Versa 6050 one of the first to ship with a 150MHz Pentium processor with MMX technology, it's backward compatible with your current Versa 6000 Series options. And our UltraCare® Program helps minimize the cost of service and support. What's more, the Versa 6200 Series will feature the fastest mobile Pentium processor with MMX technology (166MHz) and the largest screen (13.3") available in a notebook.



In addition to the enhanced productivity benefits of MMX technology, NEC PowerMate™ desktop systems come standard with Intel's LANDesk® Client Manager and NEC MagicEye™ Technology. Which, by simplifying remote management and increasing fault prevention, lower the total cost of ownership in other ways. Namely, by reducing overall system downtime.

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But you won't have to make a trade-off between increased function and ease of use. The newest member of AS/400 Advanced Series, AS/400 Entry is among the easiest servers to install, use and maintain. And AS/400 has the lowest cost of use for small businesses over a five-year period, compared to leading LAN server platforms.*

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NETWORK EDITION

MANAGEMENT AND SERVICES

Future Strategies

How to prepare your network today for the issues and uncertainties of tomorrow.



By Steve Buehler and Frank J. Derfler, Jr.

We're using this anniversary issue to look forward. In the main book, we look at today's hot technologies, while here in the Network Edition we're going to help you tackle the management and service issues that will occupy your attention for the next ten years.

You *can* predict the future. For example, you're sure that your users will want more services and that your CFO will worry about the cost of computing. The board of directors will worry about using computing power to maintain a competitive advantage, and you'll worry about quality of service. New services, cost control, competitive advantage, and quality of services are surely the four immediate concerns.

ILLUSTRATION BY PETER COATES

INSIDE

Look at how far network computing has come in the last ten years and you wonder how we all managed to keep up. Technology developments over the next decade promise to occur at an even more blinding rate now that corporate networks have met the Internet. How well you manage to keep up depends on how well you plan for change.

PLANNING FOR CHANGE is what we tackle in this Network Edition cover story. Senior networking editor Frank Derfler and PC Labs, West Coast director Steve Buehler tell you how to use network management and new network services to stay ahead of the competition during the next decade.

COST OF OWNERSHIP is the buzz phrase that everyone is using to describe the hassle that comes with maintaining armies of users and PCs. Software-metering tools can help you bring down the cost of ownership by showing you how to purchase the minimum number of software licenses necessary to maintain your users. In this Network Edition First Looks, contributing editor Steve Rigney looks at OnTrack's SofTrak for Windows NT, one of the first software-metering tools that tracks application usage from a Microsoft Windows NT Server. (Page NE14.)

SURVEILLANCE CAMERAS that work over an intranet or the Internet are hot items that we also cover in First Looks, along with a Java based terminal-emulation applet called WebTerm Toolbox, which lets you connect to a mainframe via the Web. (Page NE11.)

YOU CAN GET RICH QUICK, says senior networking editor Frank Derfler. In Multiple Access, he tells you how. (Page NE23.)

—Leon Erlanger

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Intel 200MHz Pentium® Pro processor

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- Tool-free minitower or desktop
- Microsoft® Mouse, 104-key keyboard
- Microsoft Windows® 95
- Intel LANDesk® Client Manager
- Microsoft Works preinstalled
- 5-year/3-year Micron Power℠ warranty

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- 16MB EDO RAM
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- 3.5" floppy drive
- Integrated S3 Trio ViRGE/DX graphics accelerator, 2MB EDO RAM
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- Tool-free minitower or desktop
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- Microsoft Windows 95
- Intel LANDesk Client Manager
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- 3Com 3C509 network adapter
- PCI 64-bit graphics accelerator, 2MB EDO RAM
- 3.5" floppy drive
- Tool-free minitower or desktop
- Microsoft Mouse, 104-key keyboard
- Microsoft Windows NT Workstation
- 1.2GB EIDE hard drive
- 16MB EDO RAM
- 15" Micron 15FGx, .28dp (13.7" display)
- Microsoft Works preinstalled
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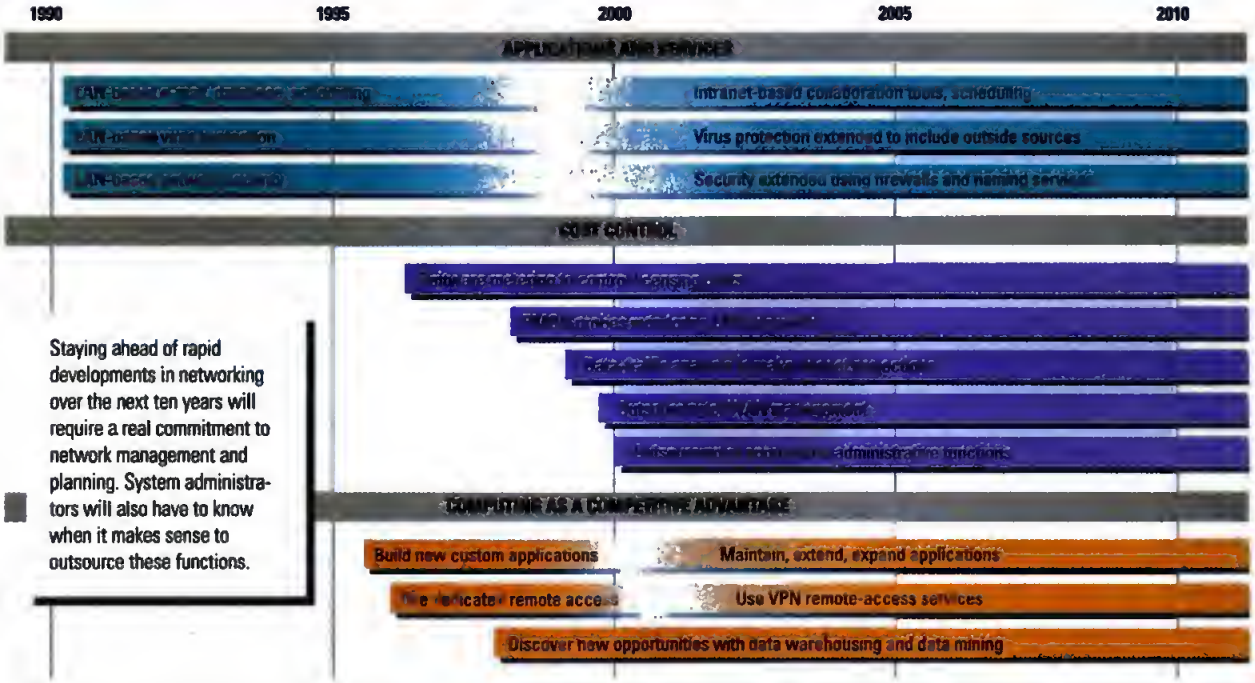
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Evolving Network Strategies



How do you travel four roads at once? One key technique is network management. There is no way you can find the time to install new services, keep things running, plan strategies, and hold down costs without the help of little software and firmware agents throughout your network. But there are other smart techniques that can help, such as outsourcing the right services, working out problems incrementally, and planning for change.

NEW SERVICES

The growth of the Internet and corporate intranets has been a major networking trend of the past year and promises to be an area of growth for several more years to come. Users want browsers, plug-ins, graphics, and video that utilize HTTP, HTML, and TCP/IP to link desktop computers to applications. Most of you will be grappling with the issues involved in setting up your company's' Web and mail servers and enabling collaboration over the network. Here are three strategies we think will help ease the way.

STRATEGY 1: In setting up your intranet, use the hardware you have and an operating system you know.

Today, Web servers will sneak into your organization as PCs did in the 1980s. But don't worry: You don't have to dive into the mysterious world of Unix to set up your intranet servers. Nor do you have to make major new purchases of powerful hardware. Our testing of Web server load balancers for "Web Server Traffic Cops," the Network Edition cover story for our issue of February 18, 1997 (available at *www.pcmag.com*), found that when it comes to intranet performance, WAN links—not server performance—are the bottleneck. And check out "Web Servers" in our issue of September 10, 1996 for reviews of the most popular Web server programs. For most purposes, any of the popular Web server programs from Microsoft, Netscape, and Novell will give your Web site all the performance it needs running on a P166 with 64MB or more of memory. The key is providing enough memory to service page requests from cache. For better performance and fault tolerance as well, set up a server farm using a load-balancing solution.

STRATEGY 2: Bring IP address management under control.

If you've got a big network or a fluid population, then the management of IP addresses for all the nodes quickly becomes a problem, especially if you're linked to the Internet.

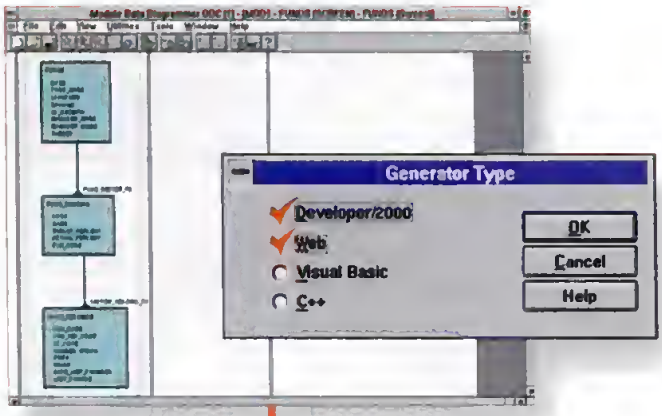
For most small and medium-size networks, the DHCP and DNS servers included in Microsoft Windows NT and NetWare provide adequate IP address management tools. But for large wide-area networks, such IP management packages as Cisco's DNS/DHCP Manager, Isotro's NetID, and Quadritek Systems' QIP can make the tasks of setting up subnets, keeping your DNS server information up-to-date, and avoiding duplicate IP addresses infinitely easier. We reviewed and tested these three products for you in "Solve the Address Mess" (Network Edition, March 4, 1997).

STRATEGY 3: Use specialized tools to link your Web servers to your corporate databases.

Linking to legacy applications via a Web server can be a challenging task. The common gateway interface (CGI) standard provides a way to pass requests from a Web server to an existing database. Specialized tools such as dbWeb and Internet Database Connector—which come with Microsoft's Internet Information Server—Netscape's LiveWire, and Oracle's Designer/2000 and WebServer 2.0 bypass CGI for tighter database connectivity. "Grab That Data(base)" in the Network Edition of September 10, 1996, has all the details. If you have your own applications

Generate Web and Client/Server Applications

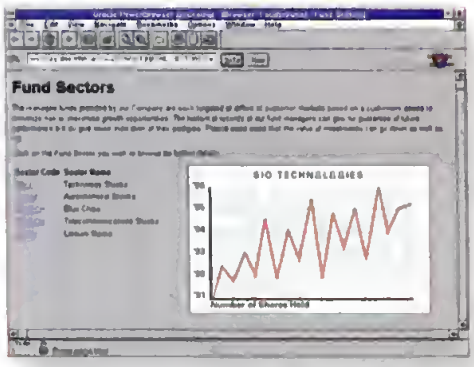
Oracle Designer/2000



Generate Client/Server Applications



Generate Web Applications



Designer/2000™ enables you to define your application visually rather than writing thousands of lines of procedural code. Then, at the touch of a button, you can generate either a Web or a client/server application — or both. So you don't have to choose between supporting your existing client/server users or moving ahead to the Web. No other toolset can do this.

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development team, it can and should learn to use these tools. If you must start a new team, however, we suggest outsourcing to a company with a proven track record instead.

COST CONTROL

Sure, every 18 months you get more computing power per dollar, but you still need more power than you have dollars.

STRATEGY 4: To control and justify the cost of computing, invest in network management tools.

Modern enterprise LAN management systems do a lot more than activate your beeper when a server goes down. They offer accounting functions—such as software distribution, license metering, and hardware inventory—that are critical to low overhead and high productivity. Security functions, such as password tracking and virus detection, become even more important when you connect to the Internet. Capacity-planning, trouble-ticketing, and event-logging features all help to justify budgets.

IBM's SystemView leads the world in management options and functions. Such management offerings as Bay Networks' Optivity, Cabletron's Spectrum Enterprise, Cisco's CiscoWorks, Newbridge's Vivid, and 3Com's Transcend are also very complete.

Frye Computer Systems' Frye Utilities and Novell's ManageWise are very complete hardware-independent software suites. Products from other software companies, including Intel's LANDesk Manager, Microsoft Systems Management Server, and Symantec's Norton Administrator for Networks, focus on cost of ownership–related functions such as software distribution, inventory, and metering. To get full functionality, you can integrate these suites with the hardware-focused configuration and reporting programs that come with a lot of network equipment.

STRATEGY 5: Establish a point of demarcation for the management of your expensive wide-area network.

As we describe in "Business Connections" elsewhere in this issue, cost and feature advantages will drive you to replace leased lines with frame relay and then with ATM virtual private network services over the next few years. Frame-relay subscribers can get valuable real-time traffic reports from their services in the SNMP format.

You should also evaluate having the frame-relay service provider (or providers—redundancy is smart) provision and maintain the communications interface equipment, provide firewall security, and guard against viruses. Instead of installing and maintaining your own remote-access server equipment, evaluate using virtual private network services for your road warriors and home workers.



Your network is a strategic advantage; being competitive depends on how well you use it.

COMPETITIVE ADVANTAGE

Your network is one of your company's strategic advantages, but being competitive depends on how well you use this resource.

STRATEGY 6: Invest in workgroup collaboration software.

Lotus Notes/Domino and Novell's GroupWise products have changed the serial approach to document creation, distribution, and changes into one of shared creativity and productivity. Even shared whiteboarding products, such as Smart Technologies' SmartBoard, enable collaboration using your network bandwidth. See "Groupware: Reaching for the Net," in our issue of October 8, 1996 for reviews of major groupware packages.

STRATEGY 7: Use data-warehousing and -mining tools to discover new opportunities for your organization.

Your company collects all kinds of information about customers, vendors, suppliers, and production. That data locked in your legacy mainframe applications is a gold mine for understanding what you do well and how to take advantage of opportunities you may be missing. Data warehouse tools consolidate information from many departments within an organization; data-mining tools use sophisticated search and statistical algorithms to discover new data patterns and relationships. Data-warehousing and data-mining tools from all major database vendors are taking decision support to new heights.

STRATEGY 8: Use intelligent server redundancy and failover to keep your network open at all times.

The strategic value of your network goes negative when you can't keep the pipes open at all times. Server-clustering solutions now offered by Digital, mirrored and standby server capability from Novell's SFT III and Vinca, and even Web server failover protection from Cisco keep you online and making money when your competition is floundering. Keep an eye out for products based on Wolfpack, a server-clustering standard that is being developed by Microsoft and various server-clustering solution vendors.

QUALITY OF SERVICE

You'll hear a lot about quality of service in the next few years. While it's important to remember that you have to keep the access pipes open, make your choices carefully. Some QOS solutions will be slow in coming, and the driving force may be more for your long-distance carrier's billing benefit than for your throughput numbers.

STRATEGY 9: Guarantee QoS over your frame-relay access devices.

ATM has been getting the headlines for its ability to support QoS by allocating bandwidth to applications, but those applications have to be written specifically to take advantage of this feature. LAN Emulation won't enjoy guaranteed QoS over ATM for a while yet. While you're waiting, though, you can guarantee QoS over your frame-relay access devices. TxPORT's 9111 family of FRADs offers buffering so that whenever your burst rates exceed the line's committed information rate, your users don't lose data. Smart use of advances such as this will let you put the guaranteed service levels where you need them.

STRATEGY 10: Remember the maxim, "Switch where you can, route where you must."

Intelligent network design and implementation will go a long way toward keeping up service, and one part of that will be looking at bigger-is-better options. Digital's GIGAswitch will lead the way for enterprise products that treat your network as an old telephony "crossbar switch"—any node can connect to any other node at impressive speeds, reducing the network infrastructure dramatically. Keep an eye out for Layer 3 switching products from major networking vendors. These promise to combine the high performance of switching with the intelligence of routing, giving you the best of both worlds. □



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First Looks

HANDS-ON REVIEWS OF NEW SHIPPING PRODUCTS

NETWORK CAMERAS

Eye on the Network

By Laura Lindhe

Lights, camera, and action can now be part of your network—and at a reasonable price. If you've been looking for a way to add value to your Web site with a low-cost "live cam" or to install a surveillance system for your intranet, network cameras from Microplex Systems and Axis Communications are worth looking over. Although placement of these devices is limited by the length of your Ethernet cable, these solutions let you add a reference on your Internet or intranet site to show off whatever you think deserves a second look.

The Axis NetEye 200 from Axis Communications and the Microplex NetworkEye/270 from Microplex Systems each combine a digital camera with a Web server. You view the images on HTML pages that can be customized via FTP. The NetEye and NetworkEye—for which you need a color Connectix QuickCam—differ in price and picture quality. The NetEye is more expensive, but its picture quality is considerably better.

The wonder of these small devices is that you don't need anything else to broadcast images of parking lots, highways, sunsets, or beaches to a browser across any TCP/IP network. These two network cameras should inspire great business plans and problem-solving ideas. In our Labs, we found both products easy to install. And neither product should impose any added work load on network administrators. In short, these cameras are practical, reliable, and useful.



Picture Quality: *Though it costs more, the Axis NetEye 200 provides better-quality images.*

Axis Communications

Axis NetEye 200

This all-in-one approach from Axis Communications, the Axis NetEye 200, includes a camera and a mini–Web server in a stylish eye-shaped case about the size of an external modem. The device provides real value because of its picture-tailoring options and dial-in modem access.

The NetEye produces video snapshots in JPEG file format using internal hardware compression. JPEG uses a smaller amount of space than .GIF but still provides a crisp image. Depending on the size of the image you choose, a file is typically 10K or 23K in size. But storage space isn't vital with the NetEye; it boasts 784K of memory.

You install the NetEye by plugging in the Ethernet and power cables. Using standard ARP, RARP, or Bootp service, you assign an IP address and match it to the physical address. The Ethernet address is printed on the unit's case. Anyone with a browser can use the IP address or camera name as a URL to view the camera's video snapshots.

At least one NetEye feature—continuous refresh of the snapshots using JavaScript—works only with up-to-date browsers. So you need to use Netscape 2.0 or later, or Internet Explorer 3.0 or later.

Just as with the NetworkEye, everything is password protected and you can make updates and changes to the camera's setup from the browser view. The NetEye gives you a greater variety of options for your snapshots than the NetworkEye, including size and resolution. In our labs, we found that the NetEye's light sensitivity was less than that of a good video recorder but good enough to provide useful images in the interior of a normally lighted commercial building.

The serial-port connection should be useful in many installations. You connect a modem to the unit using a 9-pin RS232C serial port on back of the device. Axis favors U.S. Robotics modems for this function, but the NetEye works with most modems at any speed. You can use Zmodem file transfers to grab images from the camera without a network connection. And you can administer the camera and troubleshoot the system through the serial port. You can also send updates to the unit's flash memory.

Axis added a special feature for the surveillance implementation of the NetEye: an auxiliary port that can be programmed so that door openers or other devices trip the camera to come on.

Axis NetEye 200. List price: $995. Axis Communications, Woburn, MA; 800-444-2947, 617-938-1188; fax, 617-938-6161; www.axisinc.com. *Circle 955 on reader service card.*

Microplex Systems Ltd.

NetworkEye/270

If you're a digital-camera buff, at least part of the NetworkEye/270, from Microplex Systems, may look familiar: The golf ball–shaped Connectix Quick-



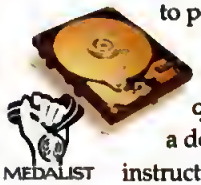
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CROSSTALK



Leon Erlanger

"These are useful products for any IP network, Frank. ISPs, municipalities, building managers, and anyone else can use them to provide publicity, information, or security through an intranet or the Internet. An ISP can offer video images as a value-added service available only to subscribers. The options are endless."

"I particularly like the design of the Axis NetEye 200, Leon. Axis is an international corporation with excellent engineering and aggressive ideas. At $995, the NetEye provides a lot of value. I expect that we'll see NetEyes at the end of a lot of URLs around the world."



Frank Derfler

Cam that takes photos in conjunction with the NetworkEye/270 server. You need either the black-and-white ($99) or the color ($299) version of the QuickCam—which must be purchased separately—to make the NetworkEye work. But even with the cost of the QuickCam, this setup is about half the price of the NetEye, making it an excellent solution if photo quality is not your primary concern.

If picture quality *is* a concern, you may want to think twice before purchasing the NetworkEye. The QuickCam uses .GIF format to take snapshots, and they aren't very clear or sharp; Microplex plans to change format support in the future. Another drawback to the NetworkEye is that, unlike the NetEye, the QuickCam doesn't have manual focus.

That the NetworkEye, which like the NetEye is a mini–Web server, works with the black-and-white QuickCam is a selling point. At $99 a camera, plus $349 for the server, using black-and-white NetworkEyes to monitor various parts of a building is a plausible and economic option, because for surveillance image quality is not as important as the ability to detect movement. And black-and-white images take about one-third less memory than color ones. This is crucial, as the NetworkEye only has 64K of storage space.

To install the NetworkEye, you plug it into the network's hub with a standard Ethernet cable. As with the NetEye, you use the ARP command—which matches an IP address to the MAC address of the unit—to assign the unit an IP address. ARP is part of the Microsoft Windows 95 TCP/IP stack; the physical address is found on the underside of the server box. In addition, a secure administration account is provided and configuration is password-protected.

To control exposure, contrast, and color control, you simply use NetworkEye's fill-in-the-blank forms and pull-down menus. Photos can be configured for three different pixel sizes. The HTML pages used for the photo background are downloaded and uploaded via FTP for editing ease.

NetworkEye/270. List price: $349. Microplex Systems Ltd., Burnaby, British Columbia, Canada; 800-665-7798, 604-444-4232; fax, 604-444-4239; www.microplex.com. *Circle 954 on reader service card.*

SOFTWARE-METERING APPLICATIONS

Save Money and Stay Legal

By Steve Rigney

How many software user licenses do you have to purchase to service all your network clients? The question is tricky, because you don't necessarily need a license for each user. Software-metering products help you get a handle on the exact number of licenses you need to satisfy your users, stay legal, and save money. Of these products, one of the first to run on Windows NT is On Technology Corp.'s SofTrack for Windows NT ($795 for 25 licenses). It runs as a Windows NT service and automatically keeps track of applications on the server.

SofTrack for Windows NT is easy to use and provides excellent reports, but it is unable to monitor applications running on clients. If you run all your applications on Windows NT servers, SofTrack can be useful. Otherwise, wait for the next version or other Windows NT–based metering products. Another consideration is that the product doesn't work with Microsoft File and Print Services for NetWare, so you can't monitor applications that are using that gateway.

To use SofTrack to share licenses across LAN and WAN links among servers running different OSs, you must have the IPX/SPX network protocol running across the links. This can be a problem, as most WAN links run TCP/IP. If you do have IPX/SPX running, you can use SofTrack's Global License Metering to share up to 65,000 licenses among an unlimited number of file servers.

SofTrack lacks other features found in the NetWare version, such as e-mail alerting and the ability to license groups of users. But if you run the package with SofTrack for NetWare, you can manage both NetWare- and Windows NT–based applications from a single interface.

We installed the product in about 5 minutes. If you want to use the Global License Metering feature, you must install SofTrack on a Windows NT server that has the IPX/SPX network protocols installed and working. Furthermore, the PC you use to install and configure the software must be a NetWare client with supervisor rights to both NetWare and Windows NT servers. To finish the installation, you must manually create your SofTrack icons on the administration PC.



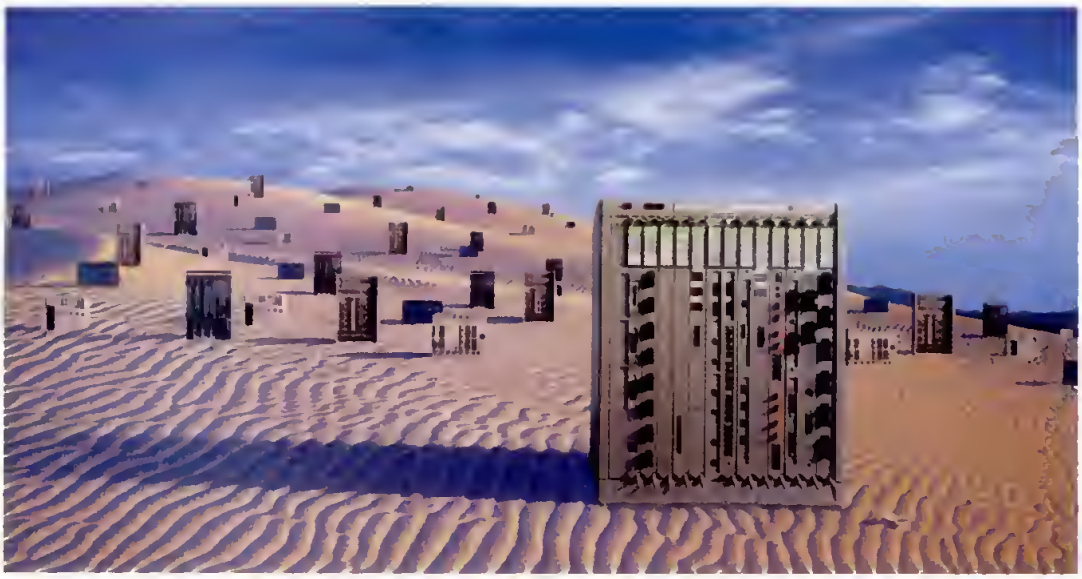
Soft Tools: *You can perform all the necessary configuration tasks from the tool bar.*

You perform all configuration and management tasks using the SofTrack administration utility. It runs on Windows NT or Windows 95, and if you're also running SofTrack for NetWare, it allows you to manage both your Windows NT and your NetWare servers. You can easily switch between servers by using an icon.

One of the most important features of a metering solution is reporting. SofTrack includes several different reports, on points such as time of use, number of users, maximum permitted concurrent use of a program, each individual's usage of a licensed program, and the number of users waiting for a metered application. Our favorite is the Cost Savings Report. It compares the maximum permitted concurrent usage to how many licenses you purchased, to help improve the efficiency of your software investment.

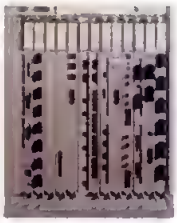
SofTrack for Windows NT. List price: For 25 licenses, $795. On Technology Corp., Cambridge, MA; 617-374-1400; fax, 617-374-1433; www.on.com. *Circle 952 on reader service card.*

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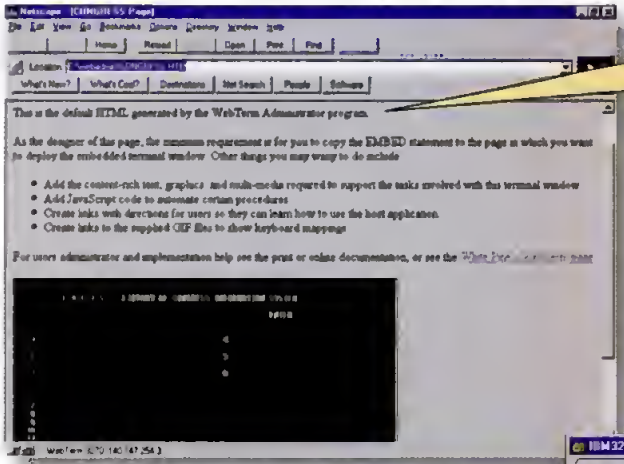
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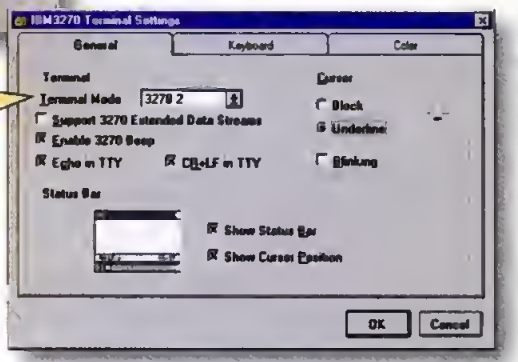
A Web Tool to Emulate

By Steve Rigney

Connecting PCs to your IBM mainframe, AS/400, or Unix host has always been an expensive and time-consuming task. Now there's an alternative to the usual nightmare of terminal emulation: WebTerm Toolbox, Version 1.0, from White Pine Software. Though it's a Web browser, WebTerm lets you connect to a host without bulky software or configuration information on network clients. The product makes creating a terminal link to a host for hundreds of computers a straightforward, 30-minute process.



Plug It In: *You can connect to your host using any Web browser that works with Netscape Plug-ins.*



Pick One: *You can use WebTerm Admin to choose the kind of terminal screen you want to embed in your Web puge.*

Traditional terminal-emulation packages are expensive—as much as $100 per PC; WebTerm is $69 per client license. More important, terminal emulators are bearish to install and configure. You have to set up the packages individually on each PC, and in many cases terminal-emulation software is not available for machines running such operating systems as Macintosh and OS/2. Also, to connect to a host you typically use TCP/IP, and though some problems in setting up clients with TCP/IP have been alleviated now that Microsoft Windows 95 and Windows NT include their own protocol stacks, these stacks can be incompatible with certain terminal-emulation packages.

WebTerm provides 3270, 5250, and VT420 terminal emulators and consists of two pieces of software: the administration utility and the browser plug-in. WebTerm Admin ($169) runs on a Windows PC and allows you to configure your host connections. The terminal plug-in—available for Windows 3.*x*, Windows 95, and Windows NT, as well as Macintosh—works with any browser capable of handling Netscape Power Plug-ins—that is, Netscape Navigator 2.0 and later, and Microsoft Internet Explorer 3.0 and later.

The heart of WebTerm is the Admin utility, which is where you define what users see. The program is extremely easy to use: You simply pick a terminal type, provide the IP address of the host, and generate a Web page. The resulting page embeds a basic terminal screen in an HTML document, which you can then customize with WebTerm Admin. You can change the basic appearance of the terminal and in some cases the size of the window. And you can even choose to add the clicking sound of a particular terminal keyboard.

The Admin utility's macro-scripting language is another useful feature that makes setting up terminal emulation easier. You can use the macro language to define a button on your Web page that automatically logs a user onto the host. You can also set up buttons to close a connection and refresh your screen automatically. In case you don't want to learn the scripting language, WebTerm Admin's Watch Me feature can record all of your keystrokes and save them in a macro script. WebTerm also allows you to map the numerous function keys of a terminal to keys on your PC keyboard; most client-based terminal-emulation programs require that radio buttons on the screen serve as function keys.

You must install the WebTerm Plug-in on every client PC that needs access to a host. The Plug-in doesn't launch, however, unless you attach it to a URL that has an embedded terminal emulator. If users don't have the Plug-in installed when connecting to a host site, they can download it from the Web server. It only takes a few minutes to download and install it—compared with the 30 minutes or more needed to install and configure most terminal-emulation products. Furthermore, with WebTerm you don't have to change any software on the client PCs when you make a change on the host. You just change the settings in WebTerm Admin and reembed the terminal in the Web page.

Another unique feature of WebTerm is its ability to open several terminal sessions on a single Web page. For example, on our tests we embedded 3270, 5250, and VT420 terminals in a single HTML document. We then connected the terminals to three different hosts, each with a different location and IP address. Then to move among the different hosts, we simply clicked on the one we wanted with our mouse. Similarly, you can have multiple terminal sessions for the same host in a single Web page.

While WebTerm can provide relief from the problems of PC-based terminal emulators, there are a few things missing in this version. WebTerm doesn't provide any encryption technology nor does it work with Netscape's Secure Socket Layer (SSL). And the plug-in is only available for Windows and Macintosh clients, so if you need to connect OS/2 or DOS PCs, you need another solution. White Pine plans to fix the plug-in problem in the next release and add the ability to work both with ActiveX scripts and more terminal types, including HP 700, X Window, and Unisys systems.

WebTerm Toolbox 1.0. List price: WebTerm Admin, $169; WebTerm Plug-in, $69 per license. White Pine Software Inc., Nashua, NH; 603-886-9050; fax, 603-886-9051; www.wpine.com. *Circle 953 on reader service card.*

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*10-minute installation assumes running Windows 95 and using Eicon's ISDN line ordering service. The ISDN line must be installed and functional at installation.

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EICON TECHNOLOGY

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ISDN ROUTERS

The RO-1 Gold Is On Fire

By Les Freed

An updated, lower-price model of Symplex Communication Corp.'s single-line ISDN router, the RO-1, the $999 Symplex RO-1 Gold offers features not always found in small-office routers. It has IP firewall and dynamic IP-addressing capabilities, making it a good choice for connecting a small LAN to the Internet.

Our only complaint about the RO-1 Gold is the same one we had about its predecessor: There is no voice support. Many competing products—Ascend Communications' Pipeline 75 and ZyXEL Communications' Prestige 28641, for example—provide one or two analog POTS jacks that allow you to use a modem, fax, or voice telephone on the ISDN line.

But despite this shortcoming, RO-1 Gold addresses two basic concerns: the expense of router access to the Internet and the security risk that IP routers pose.

Most Internet service providers (ISPs) charge more for router access than for ordinary ISDN dial-up access. Users with ISDN terminal adapters get assigned IP addresses each time they connect, but a router requires a dedicated IP address as well as a block of IP addresses for the PCs being connected. This mean extra administrative overhead for the ISP, hence the higher cost.

The RO-1 Gold appears to the ISP as a terminal adapter. So the RO-1 Gold accepts the address assigned by the ISP and communicates with the ISP's router using that dynamic address.

As for security, the RO-1 Gold's built-in IP firewall lets you allow or deny access to any IP protocol based on source, destination address, or both. The RO-1 Gold also provides an event log, so you can track attempted firewall violations.

Like most small ISDN routers, the RO-1 Gold is a modem-size package with an external power transformer. The rear panel includes connectors for the ISDN line, an RS-232 configuration terminal, and an auto-switching 10Base5/-10Base-T Ethernet port.

Symplex has made installing and configuring the RO-1 Gold as easy as possible. Typically, installing a new router in a multinode, multiprotocol network is time consuming. Each router must know the network addresses and phone numbers of other routers on the WAN. Collecting and entering this information is tedious, and one mistake can take hours to track down. If you connect the RO-1 Gold to another RO-1 or to Symplex's larger routers, the DirectRoute DR-1s, the routers learn one another's routing information automatically. Symplex calls this Silent Routing.

First-time installation requires you to attach a PC or terminal to the RO-1 Gold's serial connection, but subsequent configuration changes can be made over the LAN or WAN. A built-in configuration script, a one-page quick-start card, and a well-organized menu system guide you through installation, which takes about 10 minutes.

The RO-1 Gold can connect to two host routers at once, one on each ISDN B-channel. This allows a remote office to be connected to the main office on one channel and to the Internet on the other. If both B-channels are available, the RO-1 Gold can combine them into one 128-Kbps channel using the industry-standard Multilink PPP.

Symplex RO-1 Gold. List price: $999. Symplex Communications Corp., Ann Arbor, MI; 313-995-1555; fax 313-995-1564; www.symplex.com. *Circle 951 on reader service card.*

MULTIPLE ACCESS By Frank J. Derfler, Jr.

Get Rich Before 2007



PC Magazine may have helped more people become wealthy than any other publication, but we don't talk about it. In this anniversary edition, I'd like to share some advice on how to get rich in the next decade. Here are four paths to wealth.

1. Dig into interface hardware. The ever-dropping cost of processing power and memory, along with the new IEEE 1394 and USB ports, make once-exotic man/machine interfaces practical. Voice commands, eye flicks, heads-up displays, and even more intimate physiological interfaces really will change our relationship with PCs. Those who have done the groundwork will prosper—for a while.



2. Broker subscriber data services. There is room for a travel agent between frame relay/ATM transport providers and the passengers. As frame relay replaces leased lines, turmoil and FUD will be high. Someone who can figure out the fees, compare the services, offer unbiased advice, and make the matches can do well in areas with many competing services. If you have a combination of technical, research, and marketing skills, you can sell the same information in many different forms.

3. Be wireless. Like the airline business after World War II, the wireless WAN business is poised to take off. And as the airlines took on the railroads, wireless WAN companies with a single FCC license can come into an area and compete with cable and telephone companies who have been living under layers of regulation for decades. There's no contest: The wireless vendors will skim the cream and leave the others to haul the dull, heavy stuff. But it might not be so easy to tell Delta and American from Eastern and Pan Am.

The wireless business is now cut horizontally by companies selling transport hardware and software, and vertically by companies selling specialized applications. Transport and interface technologies of the Internet will make horizontal transport invisible and erase the walls between applications. There are gains to be made in wireless WANs for software developers and good cash flow for people who can sell.

4. Broker local content. Movies-on-demand are a bust, so work the basics. Before they look for fancy value-added stuff, people want less hassle and better access to basic services. Gather school lunch menus, help people buy stamps and check on library books, set up traffic cams, or perform one of a thousand other local-content services. Then sell it over and over— to local and national ISPs, to developers, and to broadcasters of all kinds.

These are four surefire hits for the next decade. If you don't get rich, it won't be my fault.

ILLUSTRATION BY CHRIS SPOLLEN

PC NETWORK EDITION MAGAZINE PREMIER

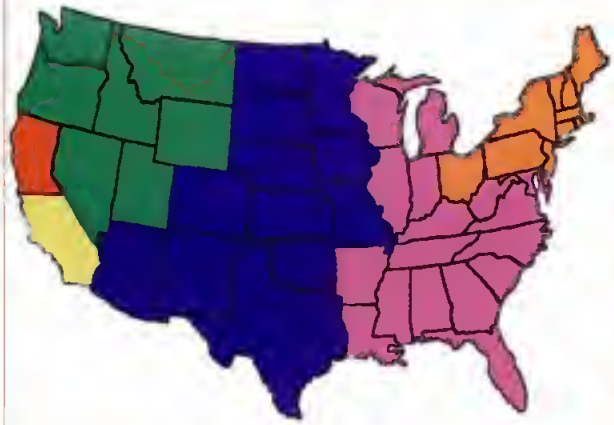
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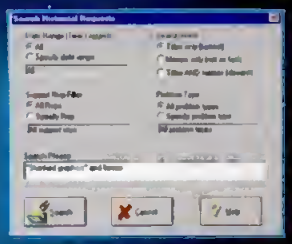
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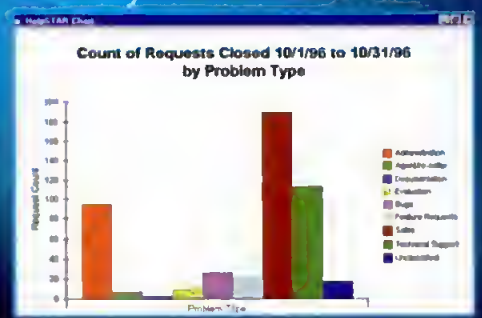
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JIM SEYMOUR

Web Follies: Checking E-Mail at 2 A.M.

Boy, our Web access has gone to hell lately: endless dialing and redialing to get through to perpetually busy lines at ISPs; long waits for pages to load; lots of reloading of pages that come in halfway and then die; getting dropped repeatedly.

Suddenly, the Web isn't so much fun anymore.

And if you rely on Internet e-mail as opposed to a proprietary system such as cc:Mail, well, plan to do without e-mail access for extended periods. In addition to checking my e-mail frequently during the workday, I also need to check in the evening. But access to the Web between about 7 P.M. and 11 P.M. through almost every ISP has gotten nearly impossible. So now I'm getting used to the unlovely idea of getting up at 2 or 3 A.M. to check my e-mail. It's an awful idea—45 minutes to an hour of reading e-mail does not make it easy to go back to sleep in the middle of a splintered night. But sometimes it's a necessity.

This is a genuinely Big Deal for many of us who need reliable, near-instant Web access. The bad news: It's not going to get better anytime soon. The worse news: The real culprits here aren't Microsoft, the government, evil telephone companies, or any of the other bogeymen we love to blame for our computer problems. The culprit is us.

Since the $19.95-per-month, unlimited-access pricing model became so popular in the middle of last year, the quality of Web access has been spiraling downward. Though America Online has taken a lot of heat after moving to that pricing in November, good ol' "America Offline" has been no worse than many other Web access entities. It takes forever to get online at busy times with The Microsoft Network, NetCom, AT&T WorldNet, or almost any other ISP you can name.



BUSY SIGNALS

The underlying problem is a fundamental change in the way we use the Web.

The underlying problem is a fundamental change in the way we use the Web. It comes as no news that Web use has grown phenomenally since late 1995. Estimates of the rate of growth in demand are all over the lot: Pick a number and you'll find a Web consultant preaching it. The exact rate of growth in demand for Web hours isn't important anymore: It's not just off the charts, it's beyond what present market mechanisms can handle.

The move to $19.95-per-month, unlimited-use billing was a natural and enormously popular response to that growth in demand. It was also the worst possible scenario for Web access reliability. People suddenly ignored how much connect time they were building up. Hey, if you have to pay a $20 admission fee at the gate, but everything's free after that, why would you worry?

Two more complications then emerged. The first was the move toward the Web as an entertainment venue. The obvious example is MSN2, the revamped Microsoft Network that was rolled out a couple of months ago. With a determined focus on delivering "shows"—comedy, insight, whatever—Microsoft moved hundreds of thousands of Web users to a usage model unlike anything we'd seen before. Instead of jumping on the Web to look up something, read the morning's headlines, or check the weekend weather forecast, people now park themselves in front of their PCs for hours on end, the same way couch potatoes fixate on their TVs.

The second complication is the fundamental change in how we use the Web that I mentioned a minute ago. Increasingly, Web users plug into the Web in the morning and stay connected all day. Many use programs like the shareware tool Ponger32 to keep "pinging" the Web so that the ISP doesn't drop the connection after *x* minutes of inactivity. Instead of accumulating perhaps one hour of Web connect time during the course of a workday or an evening at home, Web users started locking up phone lines and Web connections for 10 or 12 hours a day, or more.

And that was the straw that broke the camel's back.

We should note that this collapse happened not only in terms of the quality and reliability of Web access but also in terms of a telephone user's ability to get a dial tone for a voice call. Californians know the symptoms of the problem well: More than 40 percent of all Web connections begin or end in California, and that volume, in addition to users' newfound penchant for semipermanent Web connections, have wreaked havoc on Californians' phone service. They can no longer count on hearing a dial tone when they pick up their telephones.

We're seeing several kinds of responses to this problem.

Power & Cooling Advisor

1. Nasty, hard-to-track problems such as interference, rebooting, overheating, and hard drive read/write errors are often power supply related.

2. You can't have too much power. A power supply delivers only what the PC needs and actually performs best at 30%-70% of its rated capacity.

3. An upgrade power supply with heavy-duty input capacitors and magnetics provides protection against line voltage sags and surges.

4. The most common cooling problem is premature failure of a sleeve-bearing fan. Ball-bearing fans last 10 times longer.

5. The Arrhenius equation relates the longevity of a component to its operating temperature. Each 18°F (10°C) reduction increases component life by 100%.

6. To save money, PC manufacturers put ordinary power supplies and CPU heat sinks in their systems. **TO UPGRADE, SEE PAGE 88!**

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JIM SEYMOUR

ISPs are starting to monitor connections more closely, dropping customers' connections after just a few minutes of inactivity. (After all, say the ISPs, unlimited access doesn't mean *nonstop* access.) ISPs are starting to raise their prices, too, moving to tiered pricing, such as $30 per month for guaranteed access or $20 per month for "lots o' luck" access.

Telephone companies—the RBOCs, or former Regional Bell Operating Companies, such as NYNEX, Pacific Bell, and Southwestern Bell—are also coming up with answers, ranging from the technical to the punitive. They're worried about both their increasing inability to provide reliable dial tones for business and residential voice customers (which is, after all, their primary business) and their own profits.

Both are big issues. We need reliable dial tones for voice calls—for emergency calls to 911, for example—and we can't lose that. And since in most areas RBOCs deliver flat-rate local dial tones—systems in which you pay $15 per month, say, for unlimited local phone service rather than per-minute charges as you do for long distance—RBOC planners are terrified that we're placing all these essentially free, hours-long calls to ISPs. We'll see continuing pressure from RBOCs at federal, state, and local levels to adopt what they consider to be a fairer rate plan. If they can't get that, the RBOCs mutter darkly, they won't be able to afford to increase their physical plant rapidly enough, and reliable dial tones for voice calls will become a thing of the past.

On the technical front, RBOCs are looking for ways to manage data-call demand. SBC Communications (a.k.a. Southwestern Bell) and Northern Telecom have a promising new idea called Internet Transport Service. ISPs that sign up for ITS replace their racks of modems with ports that connect directly to their local telephone company. These data calls are then moved not over the usual voice-grade line but over a new high-speed network, as packets.

(Note the spin: Though this is pitched as a quicker, cheaper, more-reliable Web connection, the big beneficiaries will in fact be the phone companies themselves, since they will be moving this traffic over more-efficient packet-switched networks rather than over voice lines.)

I doubt that we'll really change our habit of longer Web connect times. Instead, we'll pay twice as much as we do now—for Web access almost as reliable as it once was.

You don't like that? Me neither. Send me your ideas. □

BILL HOWARD

Hardware Must-Haves

It's possible today to navigate door-to-door to most parts of the U.S. with uncanny accuracy, using a system made up of an in-vehicle GPS receiver, a CD-ROM, a microprocessor, and an in-dashboard active-matrix LCD. When you reach your destination, the voice command that also tells you where to turn says, "You have arrived." Of course, to use it, you will have to have arrived yourself, because the system that works best costs $2,800 and is available only in a new BMW.

You don't have to buy a luxury sports sedan to take advantage of this technology, however. You can get aftermarket add-ons that use the Global Positioning System (GPS) network for about $1,000 to $2,000. And I've found a GPS-plus-road-atlas package for $150 that provides half the functionality for a twentieth of the cost—just add a laptop. This is my favorite of the several useful (and in some cases, fun) PC hardware devices I've used and tested recently.



AFFORDABLE GPS

Yes, it looks kind of geeky, but the Tripmate really does help you find your way.

The **DeLorme Tripmate Hyperformance GPS Navigation Device** is a radar detector–size, canary-yellow GPS receiver that sits on your dashboard and connects via serial cable to a notebook PC running DeLorme's Street Atlas USA 4.0 (provided). You'll be able to see, within a few car lengths, where you are on virtually any street in the U.S. The Tripmate doesn't provide route directions, but it can look up any street in the atlas and then, by zooming in or out, show you where you are and where you're trying to go. If your notebook doesn't have a CD-ROM drive, you can transfer some of the map info (covering anything from a metropolitan region to several states) from the CD to your hard disk. Yes, it looks kind of geeky, but the Tripmate really does help you find your way. ($150 street; 800-452-5931; *www.delorme.com.*)

The **Xerox DocuPrint 4512** is a small workgroup printer I've favored for a long time as the ultimate *personal* printer. It's a compact, duplexing, two-bin, 12-page-per-minute, 600-dpi, PCL/PostScript laser printer with a built-in networking option. As we all know, the office isn't yet paperless. Using duplexing and the PostScript 2-up to 8-up option, each sheet of paper can hold at least four readable pages of information. The print quality is great. For the money, HP doesn't have anything close to the DocuPrint 4512. ($1,445 street with PostScript 2; 800-349-3769; *www.xerox.com.*)

The Tenba CBP series ($100 to $200 list) is the best line of backpacks I've seen. The Computer Traveler B series shoulder bags ($180 to $290 list) have nifty, removable backpack harnesses, and the Computer Air Cases ($350 to $620) are rugged, semisoft shipping cases. Because the Tenba shoulder bags I used were either too small or too big and lacked sufficient interior pockets, the Tenba product I like best is the BPS accessory harness ($30) that lets you convert virtually any shoulder bag into a backpack. Just have a good luggage-repair shop sew the included D-rings onto your bag. (212-966-1013; *www.tenba.com.*)

One of the hottest secondary uses for a PC this year will be home and business video-editing, and the neatest tool may be the much-enhanced version of the Pinnacle Systems Video Director, the **Video Director 200**. A little black box connects to your parallel port, camcorder, and VCR. When you play a tape from your camcorder, the black box watches, detects scene changes (it's pretty accurate), and pops up a tiny icon on-screen of the scene's first frame. You can drag and drop scene icons to assemble a tape in the order you want, add transitions and titles, then hit the make-tape button and walk away. True, this still isn't nonlinear editing; that is, you aren't storing video on your PC's hard disk. In a year or two, you'll be able to compress video well enough to do it on your hard disk, but for now, this is a tremendous leap forward. Workgroups that have to edit down videotape will find this cheaper than going out to an editing studio, but be warned: You still have to invest a lot of time *watching* the tape roll. ($300 street; 888-484-3366; *www.pinnaclesys.com.*)

The **Port DefCon 1** motion-sensing alarm looks like a cellular phone and connects to your notebook via a cable and your notebook's Kensington-lock slot. If any part of the setup is jostled, an alarm sounds. I wish the alarm were louder and I wish it weren't so easy to lose the locking plug, but overall, this is a handy device that will scare off most hotel thieves. ($50 street; 800-242-3133; *www.portinc.com.*) □

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(world famous artist/photographer)
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* The D-200L has 640 x 480 pixels. The D-300L has 1024 x 768 pixels.



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(digerati, composer, a pioneer in Virtual Reality)
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He's aware it's an Olympus lens, F2.8, aspherical, razor-sharp, focus-free; the automatic flash has 4 shooting modes; the resolution is striking. Now colors burst with vibrancy, images suspend belief, saturation goes richer, speed rules. But what excites him is this: it's the gateway into a fluid world. It's being able to manipulate the picture, make variations on a theme, shape it, tune it, turn it into a starting point for imagination. It's world grabbing. It's ongoing gratification. It's Olympus.

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START DOING EXTRAORDINARY THINGS

8:02AM–"Mr. Lawson, the Chairman wants to see your quarterly report in his office. The one with the singing and dancing pie charts. By 11 AM. Sharp."

8:05AM–"Help me out, Tom. The Engineering VP wants to copy our schematics this morning. Can you take your notebook there and use your Fast Infrared port?"

8:22AM–"Mr. Lawson, just a reminder, 9:30 video conference with the Frankfurt office. They received the spreadsheets you e-mailed yesterday."

8:34AM–"Thanks for those schematic files, buddy. By the way, your new notebook's under 5 pounds and mine's almost 9. You're giving me 4 strokes on the golf course, pal."

9:17AM–"Lawson, the CIO says 100BaseT Fast Ethernet is the way to go for our new office downtown. Your new notebook can access the network easily."

10:15AM–"Tom, the data you need is on multimedia CD. Bring your notebook to Marketing."

10:33AM–"Guten Morgen, Thomas. Very good conference call this morning. Sales are up as your analysis predicted. The spreadsheets really helped."

11:30AM–"Tom, this is the Chairman. Great presentation. You're going to our test site in the Mojave Desert with the Engineering VP, my friend. It's a full day of meetings, so bring an extra battery and a sleeping bag. There's no electricity."

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LOOK

ANNIVERSARY ISSUE PC MAGAZINE Fifteen Years

INTRODUCTION OF THE PC

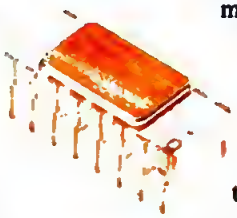
A history of the technology that changed our world.

By Michael J. Miller

On August 12, 1981, IBM executives held a press conference in New York to introduce a momentous new computer—the IBM Personal Computer, or the PC, as it became known. Immediately thereafter, work began on a new magazine, which would publish its first issue in early 1982—*PC Magazine*.

Today, 15 years later, both the PC and *PC Magazine* are still going strong. We celebrate the continued success of both with this issue. But while it would be tempting to start our history with the first issue of *PC Magazine*, or even with the introduction of the IBM PC, that would leave out too much of the story.

The personal computer industry dates back to the introduction of the first microprocessor, the Intel 4004, in 1971. But the industry really took off following the January 1975 issue of the Ziff-Davis magazine *Popular Electronics*, which trumpeted the "Project Breakthrough!" of the Altair 8800, from MITS, which the magazine dubbed "the world's first minicomputer kit to rival commercial models."



1971 Intel develops the 4004, the first microprocessor.

By today's standards, that initial kit developed by Ed Roberts, who headed MITS, a small electronics company in Albuquerque, New Mexico, was quite limited. It was based on Intel's 8080 microprocessor and had only 256 bytes of memory.

Priced at a very affordable $397, the Altair was the first personal computer widely available to the general public. It attracted hundreds of orders from electronics enthusiasts.

One who noticed this seminal event was a young Honeywell programmer named Paul Allen, who showed the *Popular Electronics* article to an old friend, a Harvard freshman named Bill Gates. The pair quickly joined forces to write a version of BASIC for the Altair. Soon, Allen went to work for MITS as its director of software, and shortly thereafter Gates left Harvard to join Allen in Albuquerque and to start a company that would later be named Microsoft. (Another early MITS employee, David Bunnell, would later start a number of computer magazines, including *PC Magazine*.)

With the Altair's introduction, the personal computer industry took off. The year 1977 saw an explosion of interest in personal computers and the introduction of a long succession of machines—the Commodore PET, the Radio Shack TRS-80, and most important, Steve Wozniak and Steve Jobs's Apple II.



1975 Steve Wozniak (left) and Steve Jobs start Apple Computer in the Jobs family garage.

Photo courtesy of Apple Computer.





1975 MITS Altair kit computer, an electronic hobbyist's dream, comes to life for only $397.

Photo courtesy of Microsoft archives.



1975 Schoolmates Paul Allen (left) and Bill Gates go corporate and establish their own company, Microsoft.

Photo: *Seattle Post Intelligencer*.

ING BACK



1979 VisiCalc demonstrates that a personal computer can be a serious business machine for anybody.

Photo courtesy of Dan Bricklin.

The Apple II quickly developed into its own standard, helped out enormously by Wozniak's 1978 design for an inexpensive floppy disk drive and—even more important—by Dan Bricklin and Bob Frankston's VisiCalc, the first electronic spreadsheet. With the introduction of VisiCalc, business people suddenly had a reason for using personal computers. It wasn't just a hobbyist's world anymore.



1978 Intel 8086 provides 16-bit power and is the initial choice for the IBM PC.

The rest of the decade saw dozens of very different designs, as one new company after another tried to define a unique combination of power, price, performance, and features. Machines introduced in this period ranged from offerings for home and hobbyist users—such as Commodore's Vic-20 and 64, Atari's 400 series, and Texas Instruments' TI 99—to more business-oriented devices, such as a series of machines from Tandy/Radio Shack and a host of designs that ran Digital Research's operating system CP/M, which was written by personal computing pioneer Gary Kildall.

Because the market was growing so fast, and because in those early days backward compatibility didn't mean much, the time was marked by a period of hardware creativity never seen since. And of course, software began to grow as well, with the rapid appearance of a variety of early programming languages, games, and even

The Perfect PC

PROCESSOR: Intel 4.77-MHz 8088

MEMORY: 64K

STORAGE: Single-sided, 160K 5.25-inch floppy disk drive

DISPLAY: 12-inch monochrome

OS: PC-DOS 1.0

Price: $2,880

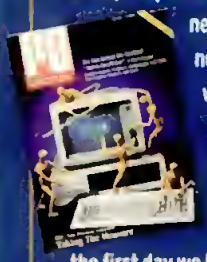


Join us online at *www.pcmag.com* to discuss the early days of the PC.

DAVID BUNNELL



I started *PC Magazine* in the fall of 1981 in the spare bedroom of my house near Golden Gate Park in San Francisco. At the time, I had this naive idea that I could run the magazine out of the house using freelancers to do the design and production. Before the first issue came out, however, there were 14 full-time people working in my house. The living room quickly became the art production room, as the work proved to be too much for the freelancers. The dining room was the sales and circulation department. The spare bedroom became the editorial office, where Jim Edlin and I wrote most of the articles. We also had a "PC Lab," but as we explained in the first issue, "at present time we have neither a lab facility nor solemn people with white coats."

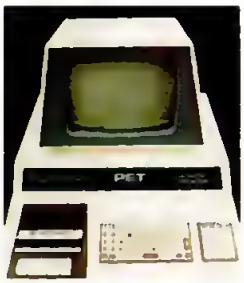


We decided that we would open a bottle of champagne on the first day we had enough mail that the postman had to deliver it in a bag. The very next day, he brought two mailbags, full of subscription forms and checks. We celebrated. And a few days later, we celebrated again, when both IBM and Microsoft signed up to be charter advertisers. In that first issue, we also trashed the PC's first word processor—a program called EasyWriter—in a review by Andrew Fluegelman, which we titled "Not-So-EasyWriter." I like to think we thereby established *PC Magazine* as the place PC users could rely on to find honest, hard-hitting product reviews—a tradition that has endured as the magazine has grown into one of the most successful periodicals of all time.

PERFECT PC ILLUSTRATIONS BY JACK MARR/SYNSUAL LOGIC. PHOTO (ABOVE): PETER STEMBER

business applications, such as the popular word processor WordStar.

Before long, nobody viewed personal computers as toys or hobbies but as devices for personal productivity with clear business applications. The era of the personal computer was firmly established. And IBM, which long had dominated mainframe computers, wanted a piece of the action.



1977 Commodore kicks off a line of several popular but short-lived machines with the PET.

Photo courtesy of the American Computer Museum.

The IBM of 1980, much more than the IBM of today, was not a company accustomed to fast-moving markets and consumer sales. It sold business machines—primarily computers and typewriters—to businesses, using its own technology and relying very heavily on a very structured system of sales and service to large accounts.



1978 Apple II hits the market.

Photo courtesy of *BYTE*

The PC business required something different. This new market was moving quite fast, and a new entrant would have to move quickly. And it would need to target individuals as well as businesses, even if the ultimate aim was to continue to sell business computers. This is what William C. Lowe, laboratory director of IBM's Entry Level Systems (ELS) unit in Boca Raton, Florida, told IBM's Corporate Management Committee, including IBM president John Opel, in July 1980.

Lowe told the committee that IBM needed to build a personal computer and that there was room in the market that Apple and others had left untapped. But, he told the committee, it couldn't be built within IBM's standard culture of the time. So they gave him the freedom to recruit 12 engineers to form a task force, called Project Chess, and to build a prototype computer.

In the next month, Lowe's task force had a number of meetings with other players in the young industry and made a number of key decisions that ultimately would affect the PC business for years to come. One was the decision to sell IBM's personal computer through retail stores in addition to offering it through IBM's own commissioned sales staff. But perhaps the company's most important decision was to use an "open architecture": to choose the basic components and operating system from sources outside of IBM. It was a big departure for IBM, which up to that point typically had designed all the major components of its machines.

In August, Lowe and two engineers, Bill Sydnes and Lew Eggebrecht, demonstrated a prototype to the Corporate Management Committee, which approved the basic plan and gave Project Chess the go-ahead to create a personal computer, code-named Acorn.

To head the group that pulled it together, Lowe turned to Philip D. "Don" Estridge, another longtime IBM employee, who worked at the Boca Raton labs. Estridge recruited a team that included Sydnes, who headed engineering, Dan Wilkie, who was in charge of manufacturing, and H.L. "Sparky" Sparks, who headed sales.

One early decision they had to make was to choose the processor to power the PC. The task force had decided they wanted a 16-bit computer, because it would be more powerful and easier to program than existing 8-bit machines. Intel had recently announced the 16-bit 8086, but Sydnes later said that IBM was concerned that the 8086 would be too powerful and compete too much with other IBM entries.

So instead they chose the 8088, a version of the chip that had an 8-bit bus and a 16-bit internal structure. This 8-bit technology offered the added benefit of working with existing 8-bit expansion cards and with relatively inexpensive 8-bit devices, such as controller chips, which could thus be incorporated easily and inexpensively into the new machine.

Another key decision was software. In July, members of the task force went to visit Digital Research to ask the firm to port its CP/M operating system to the 8086 architecture. Legend has it that founder Gary Kildall was flying his plane at the time. Whatever the reason, Kildall's wife, Dorothy, and DR's attorneys didn't sign the nondisclosure agreement IBM presented. So the IBM team left and flew north to Seattle to meet with Microsoft, from which they had hoped to obtain a version of BASIC.



1981 IBM finally makes it to the dance with its IBM PC.

Microsoft officials signed an agreement with IBM for BASIC, and soon Bill Gates and company were discussing not only BASIC but also an operating system. Quickly thereafter, Microsoft acquired an 8086 operating system that had various names, including Quick and Dirty DOS, or QDOS, written by Tim Patterson at a company called Seattle Computer Products. Microsoft further developed this operating system and licensed it to IBM, which sold it as PC-DOS.

Fevered months of putting together the hardware and software ensued. Then, on Wednesday, August 12, 1981, almost exactly a year after Project Chess was given the go-ahead, IBM introduced the IBM Personal Computer. Sold initially at ComputerLand outlets and Sears Business Centers, that first PC—with an 8088 CPU, 64K of RAM, and a single-sided, 160K floppy disk drive—had a list price of $2,880.

When the IBM PC shipped in October, Estridge—by then considered the father of the PC—and his team had a runaway hit.



1981 Osborne 1 demonstrates that portability is an early dream.

Photo: The Computer Museum History Center

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1982-83 THE EARLY YEARS

That original IBM PC had some great features—and some clear limitations. It had a 4.77-MHz Intel 8088 processor, trumpeted as a "high-speed 16-bit microprocessor," but the PC had only an 8-bit data bus. Initially, the machine came with 16K RAM on the motherboard standard, expandable to 64K, but its processor was capable of more because its 20 address bits permitted the PC to address 1 megabyte of physical memory, which was a huge leap forward at that time. While the PC was capable of displaying graphics, you had to buy an optional graphics card to do this because the base machine had only a monochrome adapter. And of course, the advertised price didn't include a monitor—or even a serial or parallel port.



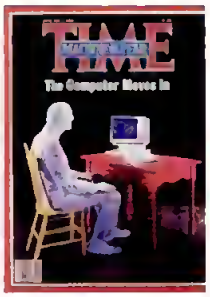
1982 The Lisa hints at the great strides in graphical computing to come from Apple.

Photo courtesy of Apple Computer

Limitations aside, it was an immediate hit. Beginning in the fall, according to IDC, IBM sold 35,000 machines by the end of 1981, and overall sales were five times initial projections. In part, the sales effort was helped by a brilliant marketing campaign featuring the Little Tramp, the character Charlie Chaplin popularized in movies such as *Modern Times*.

The technical limitations of the original PC helped spark development of other, third-party markets. For example, the 8-bit data bus opened the door for add-on board manufacturers, which almost immediately started offering boards that had serial or parallel ports, graphics adapters, or extra memory up to 256K per board. These boards could be combined so that the machine could use the full 640K of the processor's 1MB of space allocated to physical memory addresses. Different vendors offered a wide variety of add-on features. Major early players included Tecmar, Quadram, and AST, which originally gained fame with its Sixpack add-on card.

In software, the choices soon grew as well. A BASIC language was included with the PC, so many early users learned the language, ported applications from other systems, and created many interesting utilities. In particular, longtime *PC Magazine* columnist Peter Norton started a small business providing inexpensive but valuable PC utilities, and his company's rapid growth paced the multi-billion-dollar utility industry.



1982 *Time* officially confirms what PC users already know.

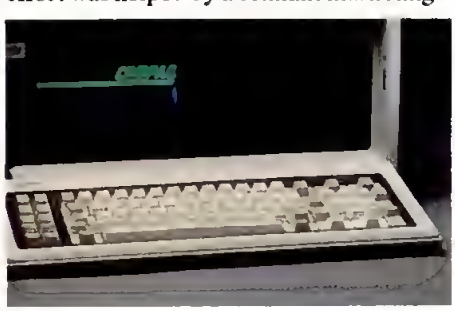
Photo © 1983 Time Inc., reprinted by permission

And of course, there was a lot of software written specifically for the IBM PC. Besides providing PC-DOS, IBM also announced support for CP/M-86 and the UCSD p-System, operating systems that provided a little competition. In fact, there were a few programs written for each of those systems, but it did not take long for PC-DOS to become accepted as the standard.

When the PC shipped, IBM announced a number of initial applications, including VisiCalc, a series of accounting programs from Peachtree Software, a word processor called EasyWriter from Information Unlimited Software (IUS), and Microsoft Adventure.

In most cases, these products were soon challenged by a variety of other packages. For instance, though EasyWriter was first, more capable products—including WordStar, then MultiMate and later WordPerfect—eclipsed it over the next several years.

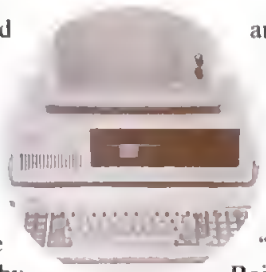
In the spreadsheet arena, VisiCalc's authors and publisher had a disagreement that delayed future versions, and it was soon challenged by new "integrated software." Most important was a new program designed by Mitch Kapor, who had earlier designed a charting package that worked with VisiCalc on Apple II machines. Kapor called his new company Lotus





1983 Compaq ships its first PC, and the clone wars begin in earnest.

Development Corp. and named his product Lotus 1-2-3. In the early days, 1-2-3 faced competition from programs like Context MBA, which relied on the UCSD p-System. But 1-2-3 was written directly to the video system of the IBM PC bypassing DOS. As a result, it was fast, and it took over the PC market. Just as VisiCalc had been the "killer application" for the Apple II, Lotus 1-2-3 played that role for the IBM PC.



1983 IBM boosts its PC line with the PC-XT.

And soon we saw a variety of programs in other fields, ranging from programs that originally started life on other platforms—such as Ashton-Tate's dBASE II—to many programs written specifically for the IBM PC, including Microsoft Flight Simulator.



1983 Borland incorporates with Philippe Kahn as its chairman.

By 1983, most major software developers were writing their software for the IBM PC, and the effect on most of the competing machines was staggering. Many companies that focused on earlier, non-IBM hardware and software standards, such as Osborne Computer, went out of business.

A number of competitors decided that DOS (the generic term for the operating system Microsoft called MS-DOS and IBM called PC-DOS) was the standard, but compatibility across many machines didn't come quite that easily. For a while, several vendors offered machines that were like the IBM PC, "only better." The DEC Rainbow offered compatibility not only with the 8088 but also with Z80 software. AT&T's 6300 and later the Texas Instruments Professional offered better graphics. And Microsoft soon pronounced that DOS 2.*x* would become the standard.

Despite this rush to DOS compatibility, all these machines ultimately failed, primarily because they couldn't run all the software that the IBM PC could. Most of the popular early applications, such as Lotus 1-2-3, WordStar, SuperCalc, and MultiPlan, were DOS applications, but they were written to circumvent DOS and BIOS code to deal directly with the IBM hardware for benefits like faster displays. Some programs were written for generic DOS and some were ported to various new machines, but soon every user wanted real IBM compatibility. Lotus 1-2-3 and Microsoft Flight Simulator were universally used as IBM-compatibility test programs, because they were written in assembly language and spoke directly to the PC's hardware. And the PC standard really began to settle in.

In 1982 three former Texas Instruments managers formed Compaq Computer Corp. to create a true IBM-compatible portable, which started shipping in March

The Perfect PC

PROCESSOR: Intel 8-MHz 8088

MEMORY: 256K

STORAGE: 360K 5.25-inch floppy disk drive, 10MB hard disk

DISPLAY: 12-inch monochrome with Hercules graphic card

OS: MS-DOS 2.0

Price: $4,995

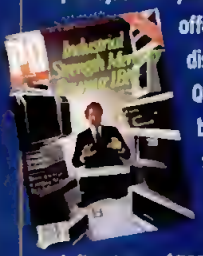


FRANK J. DERFLER, JR.



It was either brilliance or incompetence that caused IBM's PC design team to leave the system so incomplete yet so open for third-party developers. I vote for brilliance. You could argue that the incompleteness of the early PC was a marketing necessity because few buyers could afford a fully capable system in one bite.

As a result, *PC Magazine*'s readers spent much of the early eighties adding multifunction boards, graphics adapters, and hard disks to their PCs. The September 1982 *PC Magazine* listed 282 hardware products that could be installed inside the IBM PC, at that point just one year old. Tecmar offered a 5MB hard disk kit for $2,995. Quadram's Quadboard, which added the clock, serial and parallel ports, and memory IBM left out, was $595 with 64K of memory.



With all of that money at stake, objective comparative evaluations were already important to our readers. As *PC Magazine*'s data communications editor, one of the first products I examined was the AST Combo Card, which included networking in the form of Corvus Systems' Omninet. The price was more than $1,000—plus the RAM chips. In my day job, I was working on the acquisition of PCs for the entire U.S. Air Force. We estimated we'd end up buying 5,000 PCs, but that one contract ran to over 140,000 systems in two years.

Perhaps at *PC Magazine* we're still better off drilling down into product details than predicting the future. Above all, we're good at sticking to what we do best.

PHOTO: THOM O'CONNOR

1983. While not strictly the first compatible—Columbia Data Systems had shipped one earlier—the Compaq Portable showed that there was a market for a true IBM-compatible machine while gaining tremendous attention as a portable PC. Of course, in those days portable meant a mere 28 pounds.



1983
Lotus sets the pace for PC software with the introduction of 1-2-3.

IBM wouldn't introduce a similar machine until nearly a year later. And in the following years the portable field would become even more crowded as numerous companies, including Data General, Texas Instruments, Toshiba, NEC, and of course, Compaq, raced each other to field innovative, truly *laptop* computers that not only could be carried on a plane but also could be used on one.

Compaq followed its initial portable PC introduction with its first desktop PC, the Deskpro, in July 1984, and in the years that followed, PC "clones"—portables and desktops—would establish themselves as part of the industry standard.

In 1984, IBM tried to extend its standard in two ways. In March of that year, it introduced the PC*jr*, a $1,300 8088-based "home computer" that became known for its infamous wireless keyboard with Chiclets-style keys. It flopped.

IBM had much more success with its August introduction of the PC AT (for *Advanced Technology*). Based on Intel's 80286 processor, the AT cost nearly $4,000 with 256K of RAM but no hard disk or monitor. Models with a 20MB hard disk sold for almost $6,000. Most important, the AT moved the industry to the next processor level while maintaining compatibility with almost all the original PC applications.

Several important standards debuted along with the AT, especially the 16-bit expansion bus that endures as a standard today, but also including EGA graphics, which supported 640-by-350 resolution with as many as 16 colors. At the same time, IBM and Microsoft introduced DOS 3.0, which would be the standard for many years, and IBM launched TopView, an early windowing system that let users display multiple applications concurrently.

Also that year, Hewlett-Packard introduced the first laser printer, although dot matrix and daisy wheel printers continued to dominate the market for years. During this time, the first bulletin-board software packages were just starting to appear. More business-oriented online services, such as CompuServe, were still years away from market dominance.

In the early 1980s, there were still a number of other kinds of machines on the market. The Commodore 64 and the Atari 800 series were still popular home computers. But their day would soon pass, though they would be resurrected a few years later in the kind of dedicated game machines that Nintendo and Sega would create.

In the business market, CP/M still existed, but it was quickly fading from mainstream use. Apple continued to have a lot of success with the Apple II family. It failed, however, with the introduction of the Apple III and with the technically impressive Lisa, based on technology inspired by work at Xerox's famed Palo Alto Research Center. The Lisa was the first major attempt to popularize the combination of mouse, windows, icons, and graphical user interface. But at nearly $10,000, it did not gain market acceptance.

Instead, the business world was beginning to adopt programs such as Lotus 1-2-3 and WordPerfect, which soon became corporate fixtures. These programs popularized both the PC standard and the character-based DOS interface. Perhaps that interface was not as exciting as the graphics technology on the Lisa, but it worked, it was affordable, and it soon became dominant. These developments set the pace for the next decade of personal computing.

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- PCI 64-bit 3D video, MPEG, 4MB EDO RAM
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- Tool-free minitower or desktop
- Microsoft Mouse, 104-key keyboard
- Microsoft Windows 95 and MS Plus! CD
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- Number Nine® Imagine™ 128 series II video card, 4MB VRAM ..... $399 [6]

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- Extended 2nd & 3rd year on-site service[2] coverage for desktop systems (after system shipment) $139

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- Microsoft Natural Keyboard® $49
  (upgrade from standard keyboard)
- EdVenture Pak $69

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[2] Requires SCSI host adapter
[3] V.34 modem includes trial memberships to CompuServe®, Prodigy® and America Online®
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[5] Upgrade from systems with standard Micron 17" 17FGx color monitor
[6] Upgrade from systems with standard 64-bit 2MB video card

[1] 1st year on-site service is available in the United States and in limited areas of Canada from third-party service provider per customer's agreement with provider.
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MMX intel inside pentium PROCESSOR

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Slip-sheet
Front side
Fold
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3. Slice the folded edge
4. Close the page and slip-sheet
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Slip-sheet
Front side
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Ideal for upscale business professionals who want to deliver impressive presentations, the Micron™ TransPort XPE is one of the most advanced notebook PCs available.

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- Built-in stereo speakers and microphone
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- S-video and NTSC-video capability
- Built-in game port
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- Microsoft® Windows® 95 and MS® Plus! CD
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- 2nd 2.1GB modular hard drive
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- 33.6 fax/modem, speakerphone, voice mail
- Microsoft® Phone telephony software
- Internet ready: SPRYNET™ Internet trial membership, Microsoft Internet Explorer™ 3.0
- America Online® and CompuServe® trial memberships
- PCI 64-bit 3D video, MPEG, 2MB EDO RAM
- 15" Micron 15FGx, .28dp (13.7" display)
- Tool-free minitower or desktop
- Microsoft Mouse, 104-key keyboard
- Microsoft Windows® 95 and MS® Plus! CD
- Microsoft Works 4.0 CD
- System Soft® SystemWizard™ application software for automated problem resolution
- Quicken® Financial Pak: Quicken Deluxe 6.0, Quicken Financial Planner™, Quicken Parents' Guide to Money™, Quicken Family Lawyer™ and free TurboTax® 1996
- Family Pak: ABC by Dr. Seuss, Thinkin' Things™ Collection 1, Earthworm Jim™ and Mechwarrior® 2
- Microsoft Home Pak: Publisher Deluxe97, Encarta® 97 Encyclopedia Monster Truck Madness™ and CD sampler
- 5-year/3-year Micron Power™ warranty

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With Intel 200MHz Pentium processor … add $200

POWER DESKTOP SOLUTIONS

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Intel 180MHz Pentium® Pro processor

- Supports dual Intel 180MHz Pentium Pro processors
- 256KB internal L2 cache, flash BIOS
- 12X EIDE CD-ROM drive, 3.5" floppy drive
- 16-bit stereo sound and speakers
- **PCI 64-bit 3D video, MPEG, 4MB EDO RAM**
- Tool-free minitower or desktop
- Microsoft® Mouse, 104-key keyboard
- Microsoft Windows® 95 and MS® Plus! CD
- 5-year/3-year Micron Power™ warranty

- **16MB EDO RAM**
- 2.5GB EIDE hard drive
- 15" Micron 15FGx, .28dp (13.7" display)
- Microsoft Works 4.0 CD

$2,199
Bus. lease $75/mo

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- 3.1GB EIDE hard drive
- 17" Micron 17FGx, .26dp (15.8" display)
- Microsoft Office CDs

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With Microsoft Windows NT® Workstation 4.0 CD .....add $99
* Second processor requires Microsoft Windows NT® Workstation 4.0

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Dual Intel 200MHz Pentium Pro processors

- 256KB internal L2 cache, flash BIOS
- PCI 32-bit Ultra SCSI Fast-20 controller
- 12X SCSI CD-ROM drive, 3.5" floppy drive
- 16-bit stereo sound and speakers
- **PCI 64-bit 3D video, MPEG, 4MB EDO RAM**
- Tool-free minitower or desktop
- Microsoft® Mouse, 104-key keyboard
- Microsoft Windows NT Workstation 4.0 CD
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- 5-year/3-year Micron Power™ warranty

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- **128MB EDO RAM**
- 9GB Fast SCSI-2 hard drive
- 21" Micron 21FGx, .26dp (20.0" display)

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EXCEPTIONAL NOTEBOOK SOLUTIONS

TRANSPORT™ MRX

Mobile Intel Pentium® processor

- Intel 430MX Mobile PCI chip set
- 256KB L2 pipeline burst cache
- 8X modular CD-ROM drive
- PCI graphics accelerator, 1MB EDO RAM
- Pick-a-Point™ dual pointing devices
- Sound Blaster® 16-bit stereo sound
- Built-in stereo speakers and microphone
- 2 infrared ports, 1 front, 1 rear
- S-video and NTSC-video outputs
- Management Pak: MPEG Arcade™ Player, ASAP WordPower™, Quicken® SE, SPRYNET™ Internet trial membership
- Executive Travel Pak: Greg Norman Ultimate Challenge® Golf, Quicken® ExpensAble™, LapLink®, Focal Point™
- 2 modular expansion bays (hard drive, CD-ROM drive, 3.5" floppy drive, lithium-ion battery)
- Custom nylon carrying case
- Microsoft® Windows® 95 and MS® Plus! CDs
- Microsoft Office CDs
- 5-year/3-year limited Micron Power® warranty

- 133MHz Mobile Intel Pentium processor
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- 11.3" active matrix color display, 800x600
- 1.4GB removable hard drive

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- 2nd 1.4GB modular hard drive
- 2nd 2.1GB modular hard drive
- Car adapter
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MICRON EXECUTIVE DESKTOP PACKAGE:
Includes matching black 17" monitor, mouse, mousepad and keyboard

ECONOMICAL DESKTOP SOLUTIONS

MILLENNIA™ LXA P166

Intel 166MHz Pentium® processor

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- 12X EIDE CD-ROM drive, 3.5" floppy drive
- PCI 64-bit 3D video, MPEG, 2MB EDO RAM
- Tool-free minitower or desktop
- Microsoft® Mouse, 104-key keyboard
- Microsoft Windows® 95 and MS® Plus! CD
- Microsoft Works 4.0 CD
- 5-year/3-year Micron Power™ warranty

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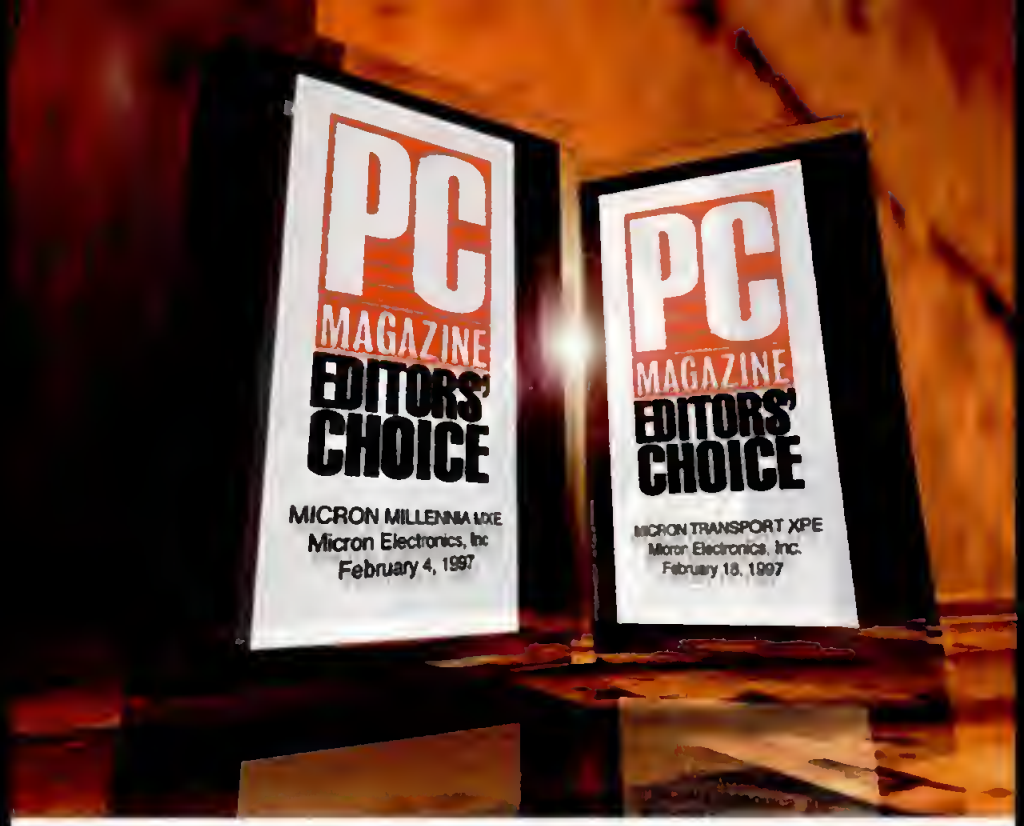
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The Micron Millennia MXE and Micron TransPort XPE blew away the competition at PC Labs, winning the prestigious *PC Magazine* Editors' Choice Award. Micron has integrated its award-winning platforms with the new MMX™ technology from Intel. And from the awards, it looks like we've done a pretty good job. Use this new technology to improve your productivity, experience clear colorful graphics and enjoy the Internet more. Make your stand. Call Micron and order a new Micron Millennia MXE or TransPort XPE.



MILLENNIA™ MXE P166

Intel 166MHz Pentium® processor with MMX™

PC MAGAZINE EDITORS' CHOICE
MILLENNIA MXe
February 4 1997

- 512KB pipeline burst cache, flash BIOS
- 12X EIDE CD-ROM drive, 3.5" floppy drive
- 100MB Iomega® Zip® drive
- 32 voice wavetable stereo sound card with speakers
- PCI 64-bit 3D video, MPEG 4MB EDO RAM
- Tool-free minitower or desktop
- Microsoft® Mouse, 104-key keyboard
- Microsoft Windows® 95 and MS® Plus! CD
- Multimedia Xcitement Pak: POD™, Adobe® PhotoDeluxe™, Billboard® Music Guide, Blockbuster Entertainment™ Guide and Grover Turnabout™
- 5-year/3-year Micron Power® warranty

- 16MB EDO RAM
- 1.6GB EIDE hard drive
- 15" Micron 15FGx, .28dp (13.7" display)
- Microsoft Works CD

$1,999

- 32MB EDO RAM
- 2.5GB EIDE hard drive
- 15" Micron 15FGx, .28dp (13.7" display)
- Microsoft Office CDs

$2,299



TRANSPORT™ XPE

Mobile Intel Pentium® processor with MMX™

PC MAGAZINE EDITORS' CHOICE
TRANSPORT XPe
February 18, 1997

- Intel 430MX Mobile PCI chip set
- 256KB L2 pipeline burst cache
- 64-bit PCI graphics accelerator, 2MB VRAM
- 8X modular CD-ROM drive
- Sound Blaster® 16-bit stereo sound
- Built-in stereo speakers and microphone
- Motorola® Montana 33.6 fax/modem
- Built-in game port
- Standard software includes Internet access, MPEG remote connection and Quicken® applications
- 2 modular expansion bays (hard drive, CD-ROM drive, 3.5" floppy drive, lithium-ion battery)
- Custom nylon carrying case
- Microsoft® Windows® 95 and MS® Plus! CD
- Microsoft Office CDs
- 5-year/3-year limited Micron Power® warranty

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- 32MB EDO RAM (80MB max.)
- 12.1" active matrix color display, 800x600
- 2.1GB removable hard drive

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- 166MHz Mobile Intel Pentium processor with MMX
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- 12.1" active matrix color display, 800x600
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1984-86 GLIMPSING THE FUTURE



As corporate users around the world were flocking to the DOS standard, they found it a big advancement over the micros of previous years. The PC standard had led to the development of the "clone" market for different kinds of machines that would run software written to the standard. And software developers everywhere were taking advantage of the growing market for new DOS applications software. It may not have been a graphical era, but it sure was productive.

And then a TV advertisement shown only once—during the 1984 Super Bowl—opened the door to the future of personal computing. It depicted a young runner dashing through a crowd of faceless drones to throw a hammer that shattered a screen image of Big Brother. "Macintosh. So 1984 won't be like *1984*." And just like the screen image destroyed by that hammer, the image of the IBM-compatible micro as the ultimate computer was shattered as well.



1984 A onetime ad during the Super Bowl launches the Apple Macintosh with a bang.

Photo courtesy of Apple Computer.



1984 Michael Dell starts building a mail-order empire from his college dorm room.



1984 Hewlett-Packard ships the first laser printer.

Suddenly, a computer could offer more than a DOS prompt and a character-based interface; it could have multiple windows, pull-down menus, and a mouse. PC users, if they noticed, waited....

It wasn't that the Macintosh wasn't appealing to PC users. It was that the Mac, unfortunately, wasn't compatible with their existing hardware and software. It also initially didn't have the applications they wanted, it wasn't expandable, and it looked a little like a toy. Still, many software vendors tried to deliver equivalent functionality in programs. If Apple, inspired by Xerox's work at its Palo Alto Research Center, pointed the way to graphical user interfaces, the PC took a circuitous route to get there. But it surely wasn't for lack of trying.



1984 IBM revs up the PC AT with an Intel 80286 processor.

One of the first PC graphical products that shipped and failed was IBM's TopView. It was only character-based, but it allowed multiple programs to run on-screen at once. Unfortunately, it wasn't all that compatible either, and developers often needed to adapt their programs to work on it. Having embraced compatibility as the watchword for "standard" computing, users stayed away.

Clearly Apple wasn't the only company committed to graphical computing. By late 1983, Microsoft had already begun working on applications software for the Macintosh, and it announced Windows 1.0 for the PC that same year. This earliest version of Windows was promised as an extension to DOS and positioned against graphical competitors of the day, notably Lisa (an earlier attempt by Apple) and VisiOn (a graphical environment promoted by VisiCorp, the publishers of the VisiCalc spreadsheet).

The Windows that was announced was very different from the Windows finally shipped, after many delays, almost two years later.

The early versions, also called Interface Manager, looked like early versions of Microsoft Word for DOS, with a single list of commands on the bottom of the screen, not the modern pull-down menus. The windows could not overlap; instead, they would only tile (an option still present in modern-day Windows but rarely used). The basics were there, including a mouse used for selecting menu items, cut-and-paste capability, and initially a list of 30 hardware vendors that would support it—which represented most of the world that supported DOS, with the notable exception of IBM.



1985 Commodore creates a cult classic with its Amiga computer.

Photo © Paul Avis, courtesy of *BYTE*.

By the time it shipped, Windows had evolved to include pull-down menus as well as the Windows Write and Windows Paint

applications and memory above 640K. But it failed to gain market acceptance, in part because there weren't very many Windows applications available, although the first PC version of PageMaker did follow in late 1986.



1985 Steve Jobs makes a hasty exit from Apple and immediately establishes NeXT Computer.

Photo: Ed Kashi

Of the many competing windowing systems subsequently released, the most successful attempt of the era may have been the entry from Quarterdeck, a small start-up in Santa Monica, California. Many power users ended up running Quarterdeck's DESQview for years as their multitasking windowing system.



1986 Compaq beats IBM to the punch with the first 80386 desktop.

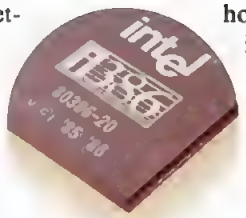
On the hardware front, although Intel introduced the 16-MHz 80386 processor in 1985, it didn't immediately find its way into IBM-compatible systems, as they were then known. Maybe vendors were waiting for IBM to take the 386 lead, but IBM had other plans. Instead it was left to Compaq and Advanced Logic Research to introduce the first 386-based PCs in September 1986.

One bright spot was that networking for personal computers was beginning to come into its own. Novell had introduced NetWare in 1983, and it was beginning to be established as a corporate standard. So was Ethernet, which had been invented in the late seventies but was just beginning to receive corporate acceptance. Another early networking force was IBM's own standard, Token-Ring, which came out in late 1985.

Compaq's 386 entry pretty much defined a new standard for the industry. Suddenly, companies didn't need to follow IBM; with new technology they could be leaders themselves. In place of a world of IBM computing, it was now the era of PC compatibles, spurred on by makers of compatible BIOSes, such as Phoenix Technologies and AMI.

Integrated software became a hot topic in 1984, with the introduction of Lotus Symphony and Ashton-Tate's Framework, programs that combined word processing, spreadsheet, graphics, and database functions into one integrated package. While these were never as successful as their developers envisioned, they foreshadowed the day when office suites would come to dominate productivity applications.

Overall, it was an era of false starts in many ways. The growth rate for sales of PCs slowed a bit, perhaps reflecting the lack of industry emphasis on home users. And much of the PC industry was on hold waiting for what was known in the press as "the PC II" from IBM and "the New DOS."



1985 Intel creates the era of 32-bit PC processors with the introduction of the 386 chip.

Photo: Thom O'Connor.

The Perfect PC

PROCESSOR: Intel 10-MHz 80286

MEMORY: 640K

STORAGE: 1.2MB 5.25-inch floppy disk drive, 20MB hard disk

DISPLAY: 14-inch CGA color

OS: MS-DOS 3.2

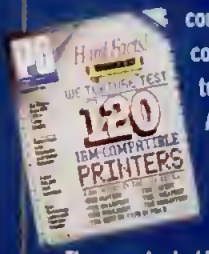
Price: $3,995



BILL MACHRONE



The IBM PC introduced a new concept to the world of personal computers: choice. With choice, however, came confusion, so we at *PC Magazine* made it our mission to create repeatable benchmark tests and laboratory conditions that would test the products fairly and accurately. Some sister Ziff-Davis publications of the time provided inspiration: *Stereo Review*'s Hirsch-Houck Laboratories and *Flying*'s tell-it-like-it-is product reviews showed that readers valued hard data and reviews that went beyond cheerleading. But *Car and Driver*'s comparison reviews defined what we wanted *PC Magazine* to be—the reader's outspoken guide through conflicting and confusing manufacturers' claims.



PC Magazine's first lab was a converted storage room. There we tested the first local area networks, using custom-designed hardware to measure multitasking performance. Three of Novell's top four employees came to install their hardware(!) and software. Bob Metcalfe, founder of 3Com, flew out to cover our whiteboard with equations that proved that CDMA collisions didn't impede network performance. In successive years, we invested heavily in PC Magazine Labs. Then as now, you readers were poised to spend a lot of money on hardware and software. We knew that the success of the PC revolution depended on your satisfaction, and we continue to do everything possible to help you make intelligent, informed decisions.

PHOTO: ANDY FREEBERG

1987-89 CORPORATE COMPUTING



By 1987 the PC world was ready for something new, which came in April when IBM unveiled its most ambitious offering to date.

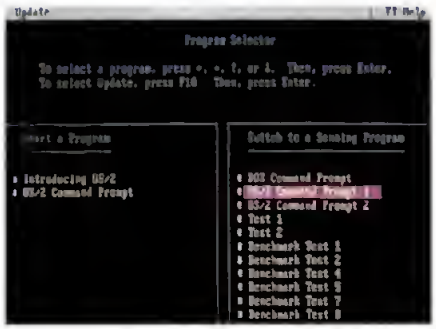
IBM's initial PS/2 machines ranged from the Model 30 (with an 8-MHz 8086 Intel processor and two 3.5-inch floppy disk drives) to the Models 50 and 60 (both with 10-MHz 286 CPUs) to the Model 80 (IBM's first 386-based machine, featuring a 16-MHz or a 20-MHz processor).

The PS/2 machines advanced the PC standard in many ways. While other companies, notably HP and Apple, had shipped 3.5-inch floppy disk drives first, the PS/2 made this a standard, in part because you couldn't get an internal 5.25-inch drive on several of these models. While other companies had previously announced graphics boards that provided 640-by-480 display resolution, the PS/2 brought with it the new Video Graphics Array (VGA) standard, which remains a standard to this day. VGA was a big improvement over the earlier EGA standard, which offered 640-by-350 resolution. Now each pixel became more "square," and the images had less distortion. VGA also allowed more colors to be displayed simultaneously on-screen.

The most controversial aspect of the PS/2, however, was its introduction of a new bus for add-on cards—the Micro Channel architecture. Micro Channel offered huge advantages over the older bus used in the AT: It was faster, it simplified the process of configuring cards, and it improved the ability of two add-in boards to work simultaneously.



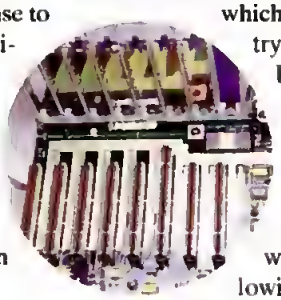
1987 The PS/2 becomes IBM's big push for a second-generation line of PCs.



1987 The continuing IBM/Microsoft partnership produces OS/2, Version 1.0.

Photo © Paul Ayus, Courtesy of *BYTE*.

But Micro Channel wasn't compatible with the preceding IBM-compatible machines and the hundreds of expansion cards already on the market. Moreover, IBM initially charged vendors significantly more money for a license to use the Micro Channel architecture than it had for the older AT design. This was IBM's attempt to regain its technical lead—and market share—from the clone vendors, and IBM was willing to go so far as to abandon hardware compatibility.



1987 IBM fights to take back market control with Micro Channel.

By November, IBM was crowing that it had sold 1 million PS/2 devices in seven months, four times as fast as it had sold a million units of its original PC.

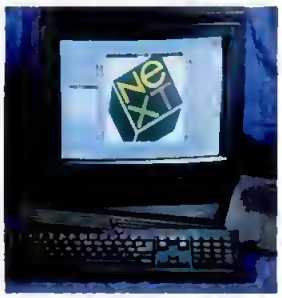
The vendors of compatible machines looked at the new specifications and gradually adapted the new 3.5-inch drive (although most software vendors had to provide their programs on both 3.5- and 5.25-inch disks for years to come) and VGA graphics standards.

But Compaq, AST, and others that had followed IBM's lead in 8088- and later 286-based (AT-compatible) computers balked at the licensing fees and the lack of backward compatibility of the Micro Channel architecture. Instead, they came out the following year with an alternative, called the Enhanced Industry Standard Architecture (EISA), which offered several advantages, such as a 32-bit-wide data path, while retaining compatibility with existing 16-bit expansion cards.

For years, the industry debated the merits of Micro Channel and EISA. Eventually, Micro Channel won support among IBM's customers, and EISA gathered some adherents for use in PC servers. But most end users continued buying add-on boards that were still AT-compatible, which came to be known as Industry Standard Architecture (ISA) boards. The era in which IBM by itself could dictate a change to the PC industry's hardware standards had come to an end.

But if the hardware world was to become fragmented following the PS/2 announcement, the effect of that development was nothing compared with the reaction to the announcement at the same time of a new operating system developed jointly by IBM and Microsoft: OS/2.

At that initial announcement, executives of both companies stood up and proclaimed their intention to make OS/2 the replacement for DOS. After all, they said, DOS was not graphical, didn't offer a standard user interface, could run only a single program at a time, and was still burdened by the 640K memory-address limit. While

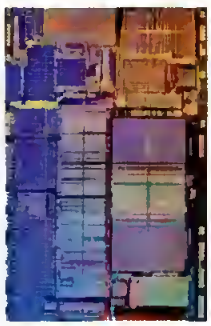


1988 After three years of development, NeXT Computer introduces the radically different Nextcube.

Photo: Thom O'Connor

Microsoft had been talking about a "multitasking DOS" for some time and IBM had long been rumored to be developing its own alternative, the two companies had signed a joint development agreement, through which OS/2 was to be the marriage of the two.

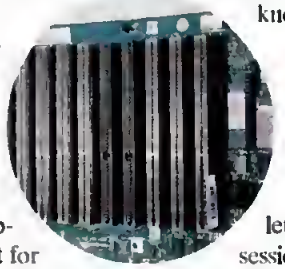
Almost from the beginning, however, that agreement was troubled. OS/2 was to ship initially in two versions. The first—which shipped in late 1987—would be OS/2 1.0, offering preemptive multitasking and support for large applications, up to 16MB, the limit of the 286 processor. But the real graphical version—the one that caught the attention of most users and developers—would be OS/2 1.1 with Presentation Manager, and that didn't ship until October 1988.



1989 The Intel 486 processor includes a Level 1 cache on the chip.

More problematic would be compatibility concerns. OS/2 was originally written for the 286, but the processor itself had some limitations. The 286 had introduced what Intel called "protected" memory and the ability to write programs beyond the 640K barrier, but it did so in a way that sometimes made it incompatible with existing 8088/8086-based software. A "compatibility box" let users run some existing DOS programs, but early versions of the compatibility box weren't all that compatible; users often called it the "penalty box."

Intel's 386 would address many of those issues by introducing what was known as Virtual 86 mode, which let a machine run multiple 8086 sessions. OS/2, however, would not support virtual mode for several years. In addition, there was confusion about a separate IBM-only version of OS/2, called the Extended Edition, which would add a database manager and communications. And some users mistakenly assumed the OS/2 name meant the operating system would work only on PS/2s.



1988 An industry coalition counters IBM's Micro Channel architecture with EISA.

Photo: Thom O'Connor

Meanwhile, Microsoft continued work on Windows, which it positioned as a product that worked on top of DOS and was a "transition" to OS/2.

In 1987, Microsoft Windows 2.0 enhanced the Windows user interface to in-

The Perfect PC

PROCESSOR: Intel 20-MHz 80386DX

MEMORY: 2MB

STORAGE: 1.44MB 3.5-inch and 1.2MB 5.25-inch floppy disk drives; 40MB hard disk

DISPLAY: 14-inch EGA color

OS: MS-DOS 3.3



JIM SEYMOUR

They were well



beyond guerrilla computing tools by then, of course. We didn't have to sneak them into our offices anymore, and we didn't have to hide them on our expense accounts. But as 1987 dawned, PCs were still far from the dominant force in business computing. Then came the explosion of PCs on corporate desktops, combined with serious networking for the first time. Yes, we were still turning those amazingly fast 386 desktop machines on end and calling them servers. Yes, setting up networks and connecting PCs to them was still far from easy. Yes,



the configurations of the machines we thought desktop rockets back then are laughable a decade later. But things had changed. PCs were part of the environment, unremarkable, ubiquitous. The war was over. When corporate America wasn't looking, we had taken over.

By then I had been writing my *PC Magazine* column for several years, having added it to my duties as columnist for our sister publication, *PC Week*. I jumped at the chance to write for *PC Magazine* because of its audience: literate people—not just computer-literate people—who really do push the gears and levers of change in computing. They know what I'm talking about, and they do something about it. And that's why I've stayed: the appeal of my new colleagues, and the bully pulpit before a smart audience of people who in their day-to-day decisions



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clude such features as overlapping windows, the ability to resize windows, and keyboard accelerators (shortcut keys). Thus, it moved much closer to today's Windows and OS/2. And it supported IBM's Systems Application Architecture (SAA) user interface standards more than a year before OS/2 would. But this version worked in 8088/8086-compatible real mode, not the 286's more sophisticated protected mode, meaning applications still couldn't multitask well and still were limited in size.

Later that year, Windows was split into Windows/286 and Windows/386, the latter of which added multitasking capabilities, the ability to run applications in virtual machines, and support for up to 16MB of memory. Windows/386 doesn't sound like much now, but at the time it was a lot. And it marked the beginnings of competition between OS/2 and Windows, though at the time both IBM and Microsoft denied this.

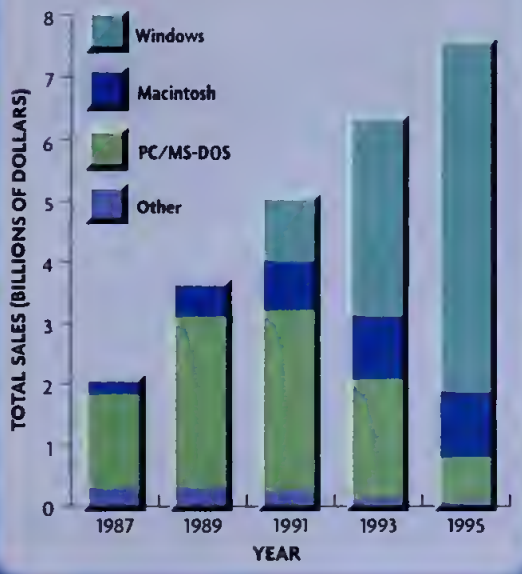
More important, it became clear that Windows and OS/2 weren't as compatible as they were initially promised to be, because the two supported very different models for writing graphics to the screen. As a result, there was confusion among software developers, who were told by Microsoft to write for Windows with the promise that the programs could easily move to OS/2 later, and who were being

The Personal Computing Industry by the Numbers

Since the introduction of the first microprocessor, the Intel 4004, the PC industry has been in a steady march forward—and upward. And there is no end in sight.

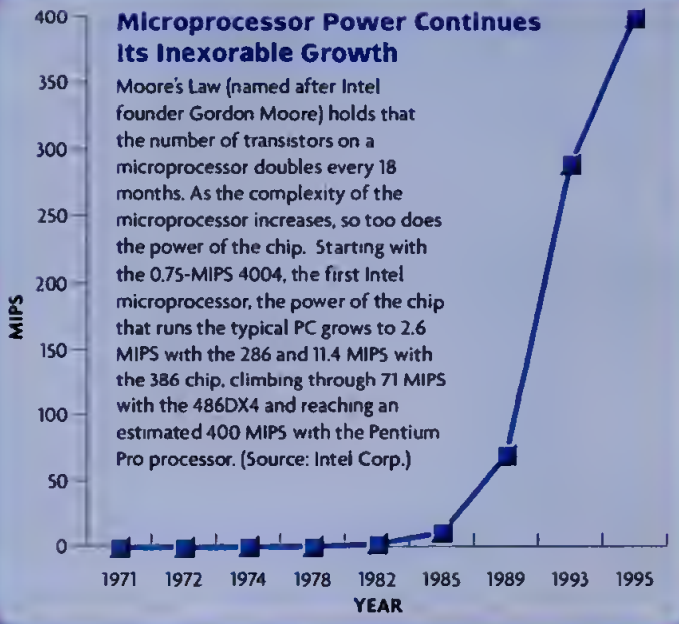
Suddenly It's a Windows World

With the introduction of Windows 3.0 in 1990, Microsoft quickly cements its position as the leading vendor of operating systems and applications software. By the end of 1995, three-quarters of all software sold is for Windows. (Source: Software Publishers Association.)



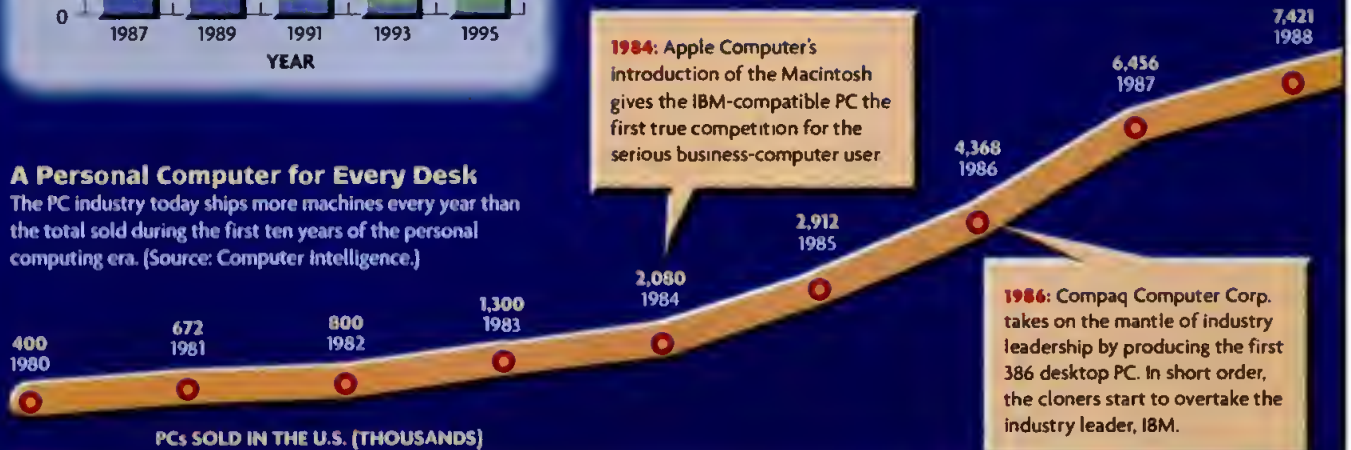
Microprocessor Power Continues Its Inexorable Growth

Moore's Law (named after Intel founder Gordon Moore) holds that the number of transistors on a microprocessor doubles every 18 months. As the complexity of the microprocessor increases, so too does the power of the chip. Starting with the 0.75-MIPS 4004, the first Intel microprocessor, the power of the chip that runs the typical PC grows to 2.6 MIPS with the 286 and 11.4 MIPS with the 386 chip, climbing through 71 MIPS with the 486DX4 and reaching an estimated 400 MIPS with the Pentium Pro processor. (Source: Intel Corp.)



A Personal Computer for Every Desk

The PC industry today ships more machines every year than the total sold during the first ten years of the personal computing era. (Source: Computer Intelligence.)



1984: Apple Computer's introduction of the Macintosh gives the IBM-compatible PC the first true competition for the serious business-computer user

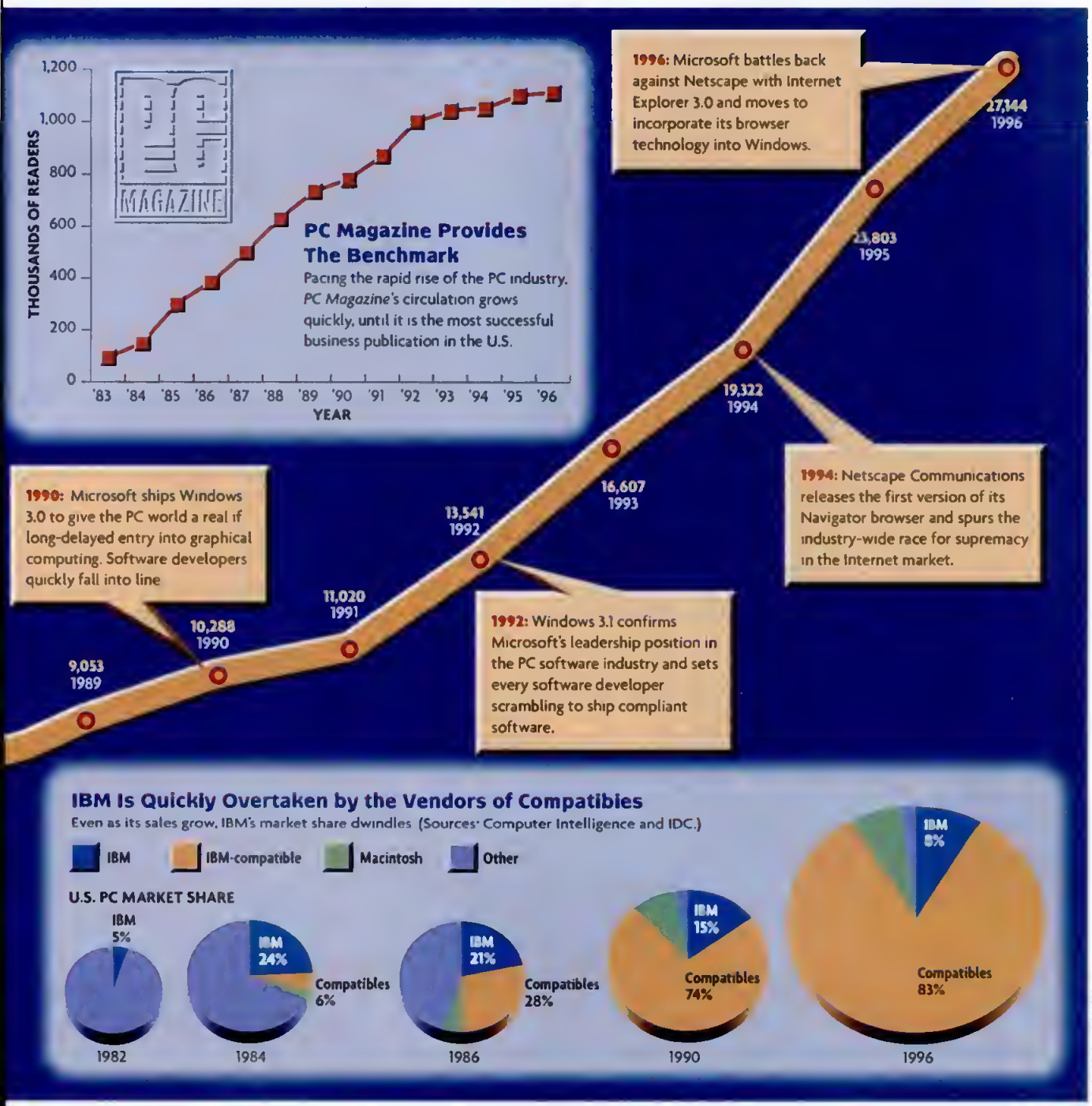
1986: Compaq Computer Corp. takes on the mantle of industry leadership by producing the first 386 desktop PC. In short order, the cloners start to overtake the industry leader, IBM.

told by IBM to write directly for OS/2.

Neither platform received a lot of support in those days. Initial application support for the Windows platform was somewhat limited, with the exception of Aldus PageMaker and Microsoft Excel, which came out in 1987. Notably, a full-featured Windows word processor would not appear until late 1989, when Samna's Ami Pro (which later was acquired by Lotus, and which survives under the name Word Pro) and the first version of Microsoft Word appeared. Just about every major developer promised support for the graphical version of OS/2, but applications were very slow in appearing.

Instead, the PC world was settling down into a world of DOS applications and basic networking. Slowly but surely, computers were becoming a part of business life for just about all white-collar workers. It wasn't exciting, but it sure worked.

Despite all the promises, the computing world at the end of the decade was left with standards that had existed for many years, such as DOS and the ISA bus, and with a lot of proposals for the future—but no clear direction. IBM had failed to set a new direction for itself and for the industry, and no other vendors had really taken over as standards-setters. Of course we didn't know it at the time, but this situation was to change very soon.



GRAPHICS: DAVID FOSTER

1990-94 THE WINDOWS ERA

Whether the computing world was looking for a new standard or not, it got one in May 1990, when Microsoft finally shipped Windows 3.0.

Windows 3.0 ran on top of DOS, so it offered compatibility with the DOS programs. It took advantage of the 386 processor, so it could multitask both those DOS programs and Windows programs. The user interface was designed to look a lot like the Presentation Manager, with both an icon-based Program Manager and a tree-based File Manager, and it included enhancements such as shaded icons. Although Windows 3.0 required minor rewrites of just about every Windows program to date, there weren't many of them to be rewritten. Most important, almost as soon as Windows 3.0 was introduced, applications appeared, led by Microsoft's own applications division and followed by just about every other major developer. Even after the Windows 3.0 announcement, Microsoft and IBM continued



1990 Microsoft puts some real life into Windows with the introduction of Version 3.0.

Photo courtesy of Microsoft archives.

to talk about OS/2 and in particular about OS/2 2.0, the first real 32-bit version, which would finally appear in 1992.

Even more confusing, while IBM was positioning OS/2 as the future operating system for all users, Microsoft was positioning OS/2 as high-end, for mission-critical and server-based applications only. Instead, Microsoft started talking about OS/2



1991 Apple's John Sculley (left) and IBM's Jack Kuehler hail the formation of Taligent and Kaleida.

Photo courtesy of Apple Computer.

3.0 (not to be confused with the later IBM OS/2 Warp 3.0), which would add improved security and multiprocessor support and would be able to execute Windows and Posix applications directly. In that scenario, Windows NT was the kernel on which DOS, Windows, OS/2, and Posix compatibility would sit.

The two companies finally split their strategies in early 1991, with IBM's Jim Cannavino and Microsoft's Bill Gates and Steve Ballmer sounding like angry spouses during a bitter divorce. OS/2 developed a strong niche in some large corporate applications, helped by its stability and robustness as compared with Windows 3.*x*. Later, IBM would make one last attempt to make OS/2 mainstream with its more consumer-oriented OS/2 Warp 3.0, which shipped in late 1994. It would sell millions of copies but not slow down the industry's broad move to Windows.

Microsoft eventually turned its one-time "OS/2 3.0" into Windows NT 3.1, which shipped in 1993 without graphical OS/2 support and found support initially as an operating system for applications servers, competing primarily against IBM's OS/2.

For most PC users, Microsoft offered the enhanced Windows 3.1 in late 1991, which added better applications integration, drag-and-drop, and simply more stability. Through the early nineties this became the dominant standard for PC applications, and Microsoft took a leadership role in defining multimedia specifications.

Microsoft came to dominate many more areas of computing in this time frame. Its Visual Basic and Visual C++ overcame big competition from Borland to dominate programming languages. And Microsoft's applications—led by its Office suite of Word, Excel, PowerPoint, and later Access—took the lion's share of the market for applications software (in part helped by delays in the Windows versions of Lotus 1-2-3, WordPerfect, and dBASE, the last of which had by then been acquired by Borland).

1992 Microsoft cements its desktop hegemony with Windows 3.1.

In this period, Apple's Macintosh line continued to grow and expand, and it found niches in graphics arts, multimedia, and education. But in most corporate and government offices the primary business system was one that followed the standards of the original PC. By then the term *IBM-compatible* had fallen out of favor, to be replaced by the processor as the primary descriptor of hardware.

The era of the 286 had already hastened to a close in late 1988 following Intel's introduction of the 386SX, a processor that had the 32-bit in-



1993 PowerPC 601 systems signal the first new computing platform in years.

Photo: Thom O'Connor.



1993 Intel tops 3 million transistors per chip with the Pentium.

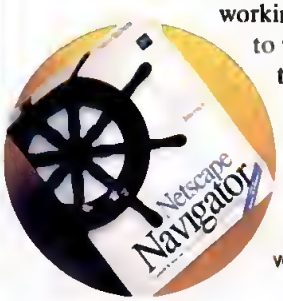
ternals of the 386 but a 16-bit data bus like the 286, which made it inexpensive. It and the original 386—rechristened the 386DX—dominated computer sales for years. In April 1989, Intel followed up the 386 with its 486 processors. With 1.2 million transistors, the 486 was effectively a faster, more refined version of the 386 plus a math coprocessor, so it ran all of the applications written for the 386 without a hitch.

This time around, no one waited for IBM or Compaq to go first. Dozens of vendors raced to have 486 machines available as soon as possible after the Intel introduction, and these machines could run as much as 50 times as fast as the original IBM PC.

Intel introduced its 60-MHz Pentium processor in March 1993, but it wasn't just processors that continued to advance. Hard disks continued to get bigger and faster. And graphics display technology progressed beyond "frame buffer" graphics cards to graphics accelerators, which worked directly with Windows to increase screen response times and to enhance all graphics.

In this period, corporate local area networking really began to take off. At the time, IBM was promoting OfficeVision, which was supposed to run on all the SAA platforms including OS/2. And just about every other giant systems vendor had its own multiplatform office-automation strategy, such as DEC's All-in-One. Almost all of these would fail relatively quickly.

What did succeed was PC servers, which hold their own data and can link to big corporate databases. On the hardware front, the Compaq Systempro, introduced in 1989, led the charge for big applications that previously had lived on minicomputers and other large systems. On the software side, SQL was coming into the market, and companies like Oracle and Sybase were beginning to target PC developers. *Rapid applications development* or RAD tools soon helped make it easier to create good user interfaces for accessing corporate data.



1994 Netscape posts the first beta version of Navigator.

Photo: Jeffrey Krein



1994 Laptops start sporting serious desktop-like features such as CD-ROM drives.

Photo: Jeffrey Krein

E-mail had begun to become a way of corporate life, with early products such as cc:Mail, later acquired by Lotus, and a host of smaller competitors. In December 1989, Lotus had changed the equation with Lotus Notes, the first "groupware" application.

By 1994, Microsoft and Intel had picked up the mantle of leadership in the PC industry, Windows was established as the standard for applications, and networking had become mainstream.

The Perfect PC

PROCESSOR: Intel 33-MHz 80486DX

MEMORY: 16MB

STORAGE: 1.44MB 3.5-inch floppy disk drive, 4X CD-ROM drive

DISPLAY: 15-inch VGA color

OS: MS-DOS 6.0, Windows 3.1

Price: $3,500



JOHN C. DVORAK



Windows wasn't the operating system of choice in 1989 when the first, funky version of Windows was in competition with OS/2 and DOS and the Mac. DOS was winning the popularity contest, but on Tuesday, May 22, 1990, that changed for good. Microsoft introduced Windows 3.0. This new version was an immediate hit. Reviewers all raved about the product. It seemed that the time had come for a Mac-like interface for everyone. People gobbled up 3.0, and the mass movement away from DOS and OS/2 and everything else had begun. As reviewers and pundits first raved about the product, they would soon begin to complain about its deficiencies, which served only to promote the next version, 3.1, which debuted on April 6, 1992. This rave-then-complain cycle would continue right through to the later releases of Windows NT and Windows 95. I've often pondered the basic attractiveness of the GUI over the command line, and I've come to a conclusion: The appeal of using a mouse to move a cursor around the screen actually brings the user into a symbiosis with the computer that can never be achieved with simple command line computing. It's this symbiosis that makes computing easy and enjoyable. Although in many ways command line computing is actually easier and more efficient, it's also too emotionally cold and detached for the majority of today's "sensitive" users.

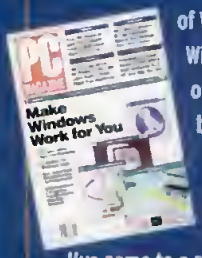


PHOTO: ANDY FREEBERG


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1995–97 THE ONLINE AGE



In early 1995, one might have expected new operating systems from Microsoft and new chips from Intel to remain the driving forces in computing for many years to come, given the history of previous years. These are still important, but perhaps the most important change in the last few years came from a group of graduate students at the University of Illinois. There, in early 1993, Marc Andreessen, Eric Bina, and others working for the National Center for Supercomputing Applications (NCSA) came up with Mosaic, a tool they would use to browse the Internet.

The Internet, of course, had been around for many years, dating back to the early 1960s when the Pentagon's Defense Advanced Research Projects Agency (DARPA) funded the connections for many university computers. As the Internet continued to grow, the government passed control of it to the individual sites and technical committees. And in 1990, Tim Berners-Lee, then at the CERN physics lab in Geneva, Switzerland, created HyperText Markup Language (HTML), an easy way to link information together among Internet sites. This in turn created the World Wide Web, which waited only for a graphical browser to begin growing like Topsy.

Once Mosaic was released to the public in late 1993, suddenly the Internet—and the Web in particular—became accessible to just about anyone with a personal computer, helped in part by the fact that you could freely download the latest version of several different browsers. And soon it seemed that just about everyone—and every company—was putting up a Web site.



1995 Windows 95 debuts after overwhelming anticipation.

Photo: Jeffrey Krein.



1996 Toshiba breaks into the desktop PC market with the stylish and feature-rich Infinia.

Photo: Thom O'Connor

New versions of Web browsers arrived very quickly as well. Soon Netscape Corp.—a new company formed by Andreessen and Jim Clark, who had been a founder of Silicon Graphics—began to dominate Web browsers. Netscape Navigator added lots of features, including plug-in support (which in turn led to many multimedia extensions) and the Java virtual machine (which let developers write Java applets that ran within the browser).



1995 Microsoft rushes to join the browser wars with Internet Explorer.

Photo: Thom O'Connor

The tremendous excitement caused by the explosion of the World Wide Web came close to overshadowing Microsoft's major announcement of the period: Windows 95. Introduced in August 1995, the software's debut was accompanied by more hype than any other computing announcement of the era.

Windows 95 was the version of Windows that many users had been waiting for. It allowed for full 32-bit applications, had preemptive multitasking, was Plug and Play–compatible, supported new e-mail and communications standards, and of course featured a new user interface. In fact, many users thought the new interface, which included a Start menu and a program desktop with folders and icons, moved Windows much closer to the original Lisa or Macintosh design of ten years earlier.

Microsoft had promised a 32-bit Windows for years, at one point saying that one would be ready in 1992, and developers had spent a long time waiting for "Chicago," as Windows 95 was known during development. Once shipped, Windows 95 quickly became a standard for end-user computing, with many vendors having 32-bit versions of their applications ready when the new OS shipped or shortly thereafter. Microsoft followed Windows 95 less than a year later with Windows NT 4.0, which incorporated the same user interface and ran most of the same applications using the Win32 programming interfaces. Windows NT rapidly found favor among corporate IT managers because of its more stable design.

Still, there is lots of room left for advances in operating systems. For years, software vendors have been talking about object-oriented languages (such as C++) and a more object-oriented operating system. In such a design, data and applications should be split up, so that users might work with data independent of individual applications. Ideally, objects

could be spread out or distributed among multiple computers.

Microsoft has been talking about this concept for years, notably in Bill Gates's November 1990 "Information at Your Fingertips" speech, which emphasized the concept that all the data a user may need could someday be accessed from a personal computer regardless of where the data actually resides. The idea, he said, was to move beyond applications and think about data. This direction led to Microsoft's emphasis on compound documents, macros that work across applications, and a new file system. Some parts of that vision—called Cairo—are part of the Windows 95 interface and Object Linking and Embedding (OLE). Other parts are still on the drawing board.



1995 Java becomes an instant addiction.

Of course, Microsoft's competitors have continued down their own paths. In 1989, Steve Jobs's NeXT Computer came up with an object-oriented OS, which was targeted toward corporate customers and recently was acquired by Apple Computer. In the early nineties IBM and Apple merged two of their projects—Apple's "Pink" OS and an IBM/Metaphor experiment called the Patriot Partners—to create Taligent. This project resulted in a fairly extensive series of frameworks for developers to use in creating object-based applications. But though the frameworks were recently added to OS/2, plans for Taligent as a separate OS have been shelved.

Other object-based technology is in various stages of development.



1996 Windows CE devices give the slumbering hand-held market a needed boost.

Photo: Geoffrey Nelson

Microsoft's OLE, which allows for compound documents, has been improving and is now a part of the firm's ActiveX specification. Apple, IBM, and others came up with an alternative specification called OpenDoc, and such components are now called LiveObjects. IBM defined a standard for objects to work together across a network called the Systems Object Model (SOM), which competes with Microsoft's Component Object Model (COM).

But all of this has been overshadowed in recent months by Sun Microsystems' Java, which started life as a variant of C++ designed for use on the Internet. In the last year, it has grown to include a virtual-machine implementation that has been incorporated in Netscape and Microsoft browsers, as well as the latest version of IBM's operating system OS/2 Warp. Many



1996 The U.S. Robotics Pilot: Finally, a PDA that's chic (not embarrassing) to carry.

Photo: Thom O'Connor

The Perfect PC

PROCESSOR: Intel 200-MHz MMX Pentium

MEMORY: 32MB

STORAGE: 1.44MB 3.5-inch floppy disk drive, 2GB hard disk, 8X CD-ROM drive

DISPLAY: 17-inch SVGA color

OS: Microsoft Windows 95

Price: $3,500



DON WILLMOTT



The Internet made the cover of *PC Magazine* long before it was on the cover of *Newsweek*. But then again, cyberspace has never been terra incognita for *PC Magazine*. After ten years of online publishing experience, we were ready (almost) for the explosion of interest in the World Wide Web in 1995. By the beginning of 1996, our Web site, PC Magazine Online, was getting 150,000 page requests a week. By the end of the year, it was getting 225,000 requests a day. How do we keep that number rising? Like everyone who publishes on the Web, we spend enormous amounts of time thinking about, discussing, and even fighting about how to deliver meaningful information online in an interactive way. One thing's for sure: Just because you know how to do it well on paper doesn't mean you automatically know how to do it well online. One big advantage the Web has over print is its limitlessness. That means we are able to expand on the magazine-based stories we create and use the *PC Magazine* site to present stories and special features that might otherwise fall by the wayside, all with a turnaround time of hours rather than weeks. Our "Internet-User" section, where we've posted more than 500 constantly updated Web-related product reviews, is just one example of the kind of industry and technology coverage we can provide online that we can never replicate in print. Even now, more than two years into our Web adventure, we are still learning—just like you.

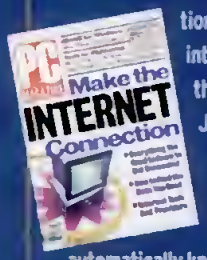


PHOTO: THOM O'CONNOR

developers are currently developing applets and even full applications within Java, with the hope that this will free them from having to rely on Microsoft standards. More recently, Sun, Netscape and others have been promoting the JavaBeans specification as a great way of linking objects.

On the Web itself, a current push is for technologies and products that allow content to be delivered automatically over the Internet, so that users don't have to search out specific information. Pioneered by PointCast, which implemented a screen saver that collects information from many sources, this approach is being pursued by several new competitors, including Castanet and BackWeb. And both Netscape and Microsoft are now promising background delivery of Internet content, with Microsoft even talking about making it a part of the Windows desktop.

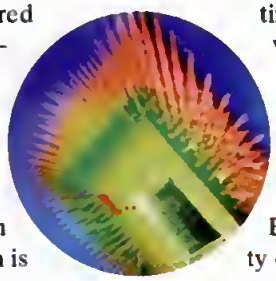
Keeping pace with these software developments, computer hardware continues to evolve.

Faster and faster machines remain the watchword. Intel's Pentium processor with 3.2 million transistors was introduced in 1993 and by 1995 had become the standard processor in mainstream computing. Intel has since followed this up with the Pentium Pro processor, offering even better 32-bit performance.

In early 1997, Intel introduced the MMX instructions, the first major enhancement to the Intel instruction set since the 386. These instructions, which are designed to improve game and multimedia performance, will be added to both Pentium and Pentium Pro designs. Intel's competitors—notably AMD and Cyrix—plan chips that will be competitive with the Pentium Pro and include MMX instructions as well.

At the same time, other hardware continues to evolve. Graphics adapters have become faster and more powerful and are now adding new 3-D capabilities, particularly exploiting the Direct3D features in Windows. Hard disks continue to get faster and larger; in early 1997, hard disks larger than 2 gigabytes are beginning to become standard features of high-end PCs.

CD-ROM drives came into the market in 1985 but didn't begin to take off until the early nineties. Now they are a standard part of virtually all desktop machines sold into the home and small-business markets, and the preferred way of loading applications. CD-ROM speed has improved markedly; today 12X CD-ROM drives (those that spin at 12 times the speed of the first drives) are becoming standard.



1997 Intel adds multimedia extensions to the Pentium processor with MMX.

Photo: John Wilkes.

But where the 660MB capacity of a CD-ROM once seemed enormous, the coming DVD standard—which allows at least 4.7GB of storage on a single disk of the same size—dwarfs it. That's enough for a full-length movie, perhaps with multiple languages or multiple endings.

Even printers have advanced at an amazing pace. Laser printers have become the standard corporate printers, offering excellent black-and-white printing, often at high speed, in printers shared over a network. In the home market, color ink jet printers have become the standard, offering great black-and-white and good color printing for well under $400.

Meanwhile, some companies—notably Sun and Oracle—are arguing that the speed of machines is no longer as important as it used to be, because of the prevalence of the Internet. Instead, they are promoting a new Network Computer (or NC) specification, which argues for "thin clients" with most processing taking place on servers, where the operating system and all applications reside. Such systems, they argue, would be easier to administer and thus would offer a lower total cost of ownership. Microsoft and Intel are fighting back with a NetPC specification, which they maintain would have the same advantages plus the additional power and flexibility of PCs because NetPCs would run Windows and existing applications and would allow for standalone computing.

How many and which of these hardware, software, and networking initiatives will succeed? As always, it's hard to tell. But it is clear that the Internet and the Web will be major factors in the years to come, as will the inevitable increases in hardware and software capabilities.

What also is clear is that even though the last 15 years in the PC industry have been a wild ride, the next 15 promise to be even more interesting as the pace of technological development continues to accelerate.

For Further Reading

FIRE IN THE VALLEY:
The Making of the Personal Computer *by Paul Freiberger and Michael Swaine (Osborne/McGraw-Hill, 1984).*

BLUE MAGIC:
The People, Power & Politics Behind the IBM Personal Computer *by James Chposky and Ted Leonsis (Facts on File, 1988).*

BIG BLUES:
The Unmaking of IBM *by Paul Carroll (Crown Publishing, 1994).*

ACCIDENTAL EMPIRES:
How the Boys of Silicon Valley Make Their Millions, Battle Foreign Competition & Still Can't Get a Date *by Robert X. Cringely (Harper Business, 1993). Video version: "Triumph of the Nerds" (PBS, 1996).*

GATES:
How Microsoft's Mogul Reinvented an Industry & Made Himself the Richest Man in America *by Stephen Manes and Paul Andrews (Simon & Schuster, 1994).*

THE ROAD AHEAD
by Bill Gates, with Nathan Myhrvold and Peter Rinearson (Viking Penguin, 1996).

MICROCOSM:
The Quantum Revolution in Economics & Technology *by George Gilder (Simon & Schuster, 1989).*

THE CHIP:
How Two Americans Invented the Microchip and Launched a Revolution *by T.R. Reid (Simon & Schuster, 1985).*

COMPUTER PIONEERS
by J.A.N. Lee (IEEE Computer Society Press, 1995).

THE 8TH ANNUAL COMPUTER INDUSTRY ALMANAC
by Karen Petska-Juliussen and Dr. Egil Juliussen (The Reference Press, 1996).

ENCYCLOPEDIA OF COMPUTER SCIENCE, THIRD EDITION,
by Anthony Ralston and Edwin D. Reilly (Van Nostrand Reinhold, 1993).

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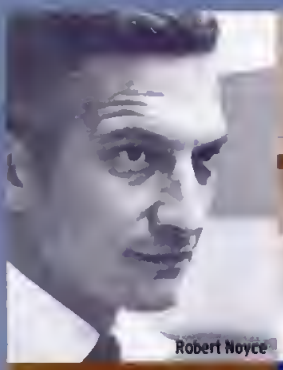
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CIRCLE 220 ON READER SERVICE CARD


Robert Noyce


Dennis Hayes


Gary Kildall


Bob Frankston


Dan Bricklin


Ed Roberts

THE MEN WHO CHANGED OUR WORLD

Today the personal computing industry is worldwide and enjoys an unprecedented diversity among its millions of users, sellers, builders, and planners. But a look at the faces of the men who built this world reminds us that in the early years, personal computing was almost exclusively an American phenomenon and overwhelmingly male. Of the hundreds of people who pioneered personal computing, here are a handful of those whose names spring to mind when we remember the early years.

Robert Noyce, coinventor of the integrated circuit, was also cofounder of Fairchild Semiconductor and in 1968 joined with **Gordon Moore** to start Intel.

Douglas Englebart is credited with inventing the computer mouse in the mid-sixties while working at the Stanford Research Institute. He went on to develop the first windows system, hypertext, and many other personal computing technologies.

Ted Hoff led an Intel team, including **Stan Mazor**, **Federico Faggin**, and **Masatoshi Shima**, that in 1971 developed the first microprocessor, the 4004.

Ed Roberts founded MITS, which in 1975 began selling the $397 Altair kit computer—the first true personal computer, which Roberts codesigned with **Bill Yates**.

Paul Allen and **Bill Gates** were high-school chums whose extracurricular interest in computing led to the 1975 formation of Microsoft.

Steve Jobs and **Steve Wozniak** in 1976 soldered and hammered together the first Apple computer in the Jobs family garage. In short order, their company gave personal computing the direction it still follows today.

Gary Kildall in 1972 wrote the first programming language for the Intel 4004. He later founded Digital Research to sell his operating system, CP/M, which paced the early micro industry.

Arthur Rock had the money and the vision to invest in several of the seminal personal computing ventures, notably Apple Computer and Intel, helping give birth to an industry.

Dan Bricklin and **Bob Frankston** launched VisiCalc in 1979, prompting thousands to recognize that micros were not just for hobbyists anymore.

Dennis Hayes shipped the first PC modem in 1979 and made it clear that any computer is effective only when connected to the rest of the world.

Philip D. ("Don") Estridge led the team that flouted IBM's corporate mores to produce the IBM PC within one very busy year.

Rod Canion in 1982 joined with **Jim Harris** and **Bill Murto** to establish Compaq Computer Corp. and showed the computing world that there's more than one way to be IBM-compatible.

Mitch Kapor founded Lotus in 1982 and began marketing 1-2-3, coauthored by **Jonathan Sachs**. The integrated program set the direction for the micro software industry.

Photos: Robert Noyce courtesy of Intel, Gary Kildall © Tom G. O'Neal, Steve Jobs, The Bettmann Archive, Steve Wozniak courtesy of Apple Computer, Paul Allen courtesy of Microsoft archives, Bill Gates courtesy of Microsoft archives, Ed Roberts courtesy of Steve Shepard


Philip Estridge


Rod Canion


Mitch Kapor


Steve Jobs

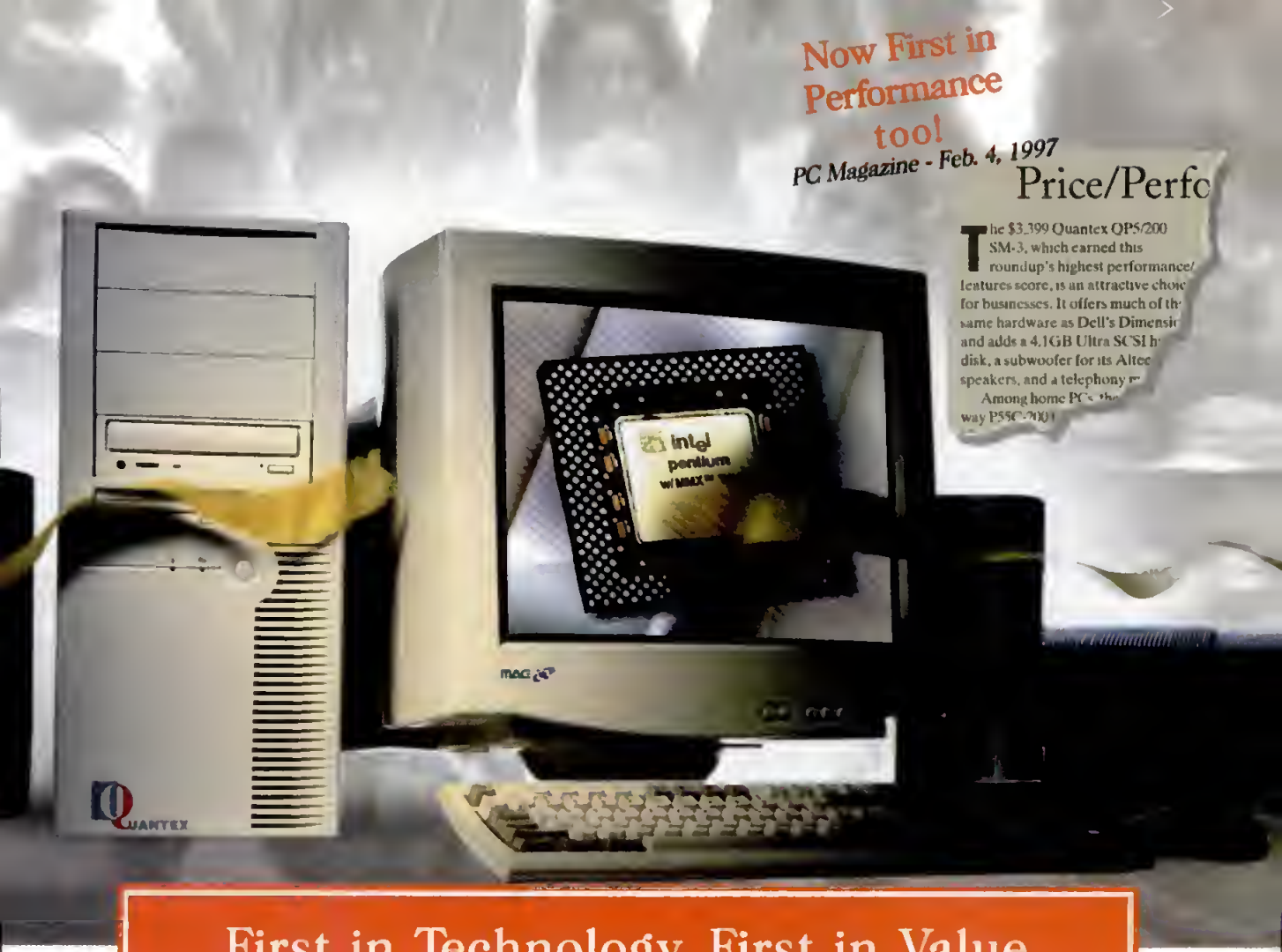

Douglas Englebart




Paul Allen


Arthur Rock


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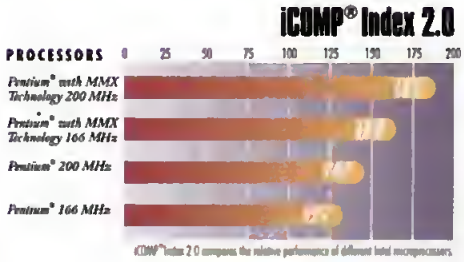
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PC Magazine, 2/4/97

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LOOK



TECHNOLOGY ON THE WAY

The ten technologies that will determine the course of personal computing in the year 2000 and beyond.

By Bill Howard

In the late 1400s, Leonardo da Vinci conceived—as sketches in his notebooks—airplanes, helicopters, and parachutes. It took centuries for these conceptions to become products, because in da Vinci's time the gulf was so vast between what his mind could imagine and what technology could deliver.

Today, we are similarly frustrated because what we imagine—continuous speech recognition, for instance, or software that acts on our behalf—might take a decade or two to go from technical concept to working product. No matter how fast the pace of progress, we want it to be faster. Still, actual progress clearly is faster each year.

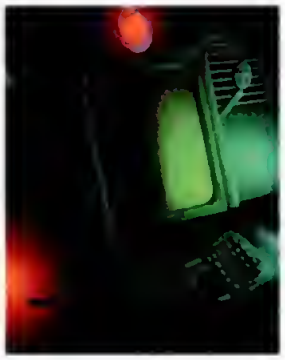


In this section, *PC Magazine* examines ten of the most important unfolding technologies of today that hold the most promise for tomorrow. They have the potential to reshape the way you work and live in the coming years and decades. At the very least, they'll make your computer run faster and let you hold more information in ever-smaller boxes.

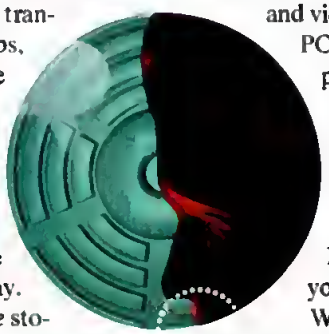
Specifically, the topics covered here are home and business PCs; the microprocessors that power them and the storage and display technologies that make them productive; distributed computing; alternate user interfaces and agent software; and business networking and connectivity to the home.

In each case, we describe where the technology is today, what's transpiring in the research labs, and where we believe the technology will be in the next 5 to 15 years. In addition, for each technology covered, at PC Magazine Labs we've reviewed the leading examples of the technology as it exists today. Unlike most *PC Magazine* stories, these aren't intended to report comprehensive A-to-Z tests of all products. Rather, we've picked the most promising and the most intriguing examples, as you'll read in the second section on each topic.

Although much of the future of technology is a subject for conjecture, we do know that the computer of 2010 will be a cross between things that might seem familiar to you and to George Jetson. The majority will be laptop-size, because the components won't need more room than that. Processor speeds will be measured in gigahertz rather than megahertz; RAM will perhaps be measured in gigabytes rather than megabytes, and who knows how much disk capacity we'll have? There will be many mass storage alternatives, but for all the gee-whiz technology we've seen, we're most impressed by what you still can do with rust—iron oxide, the coating on the good old Winchester-technology hard disk.



PCs will be TVs, high-definition TVs will be PCs, and they will all have telephones and video cameras attached. The PC may become a multipurpose device controlling heat and security in the home; conversely, security devices and thermostats may become little PCs that talk to other PCs in your home. PCs could do the same for your office at work.



We expect voice recognition and handwriting recognition to supplement but not replace the keyboard in the foreseeable future. And that means that no matter how small you might someday make a computer, you shouldn't make your main computer much smaller than today's notebook computer. Your

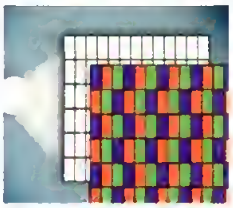
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ING FORWARD



fingers rebel at a keyboard less than 10 inches across, just as your eye looks askance at displays that try to cram information on something much smaller than a sheet of paper.

Voice and signature recognition could be ingredients for better security; also for better global communication. Today we're at the cusp of continuous speech recognition, not just speak-slow-ly-in-to-the-micro-phone recognition. In part, this advance is because of the machines' improved ability to understand contextual soundalikes and phrases ("Did you go to the store for two lemons, too?").



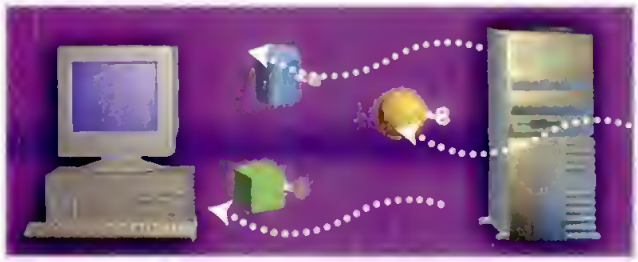
Some technologies central to the PC today could well fade. The CD or DVD drive is a godsend now. But will you need either if you have an ultrafast connection into your home or office and can get any piece of data from any place instantly? If you do have an infinitely fast data pipe (or seemingly so), then it's possible that there will be a place for a network computer, a device that displays information and calculations done at the far end of the wire.

One of the murkiest areas is projecting the technology we'll use to get all that data: Hyperfast phone line? Cable TV cable? Satellite dish? And what kind of vendor will provide it? Other technologies might fade without ever reaching the potential once ascribed to them: The 64-Kbps ISDN technology that seemed blindingly fast when modems ran at 2,400 bits per second seems stagnant now that modems are approaching 56,000 bps.

The human mind can absorb and act on a bit more information each year, but the amount of information being aimed at us increases geometrically. The next 15 years will see big strides in technologies that help us filter and act on all the data we get. Why, for instance, couldn't a smart agent track the individual schedules of the members of a workgroup and determine the best time for them to meet?



Back in the 1400s there were no venture capitalists bothering Leonardo over time-to-market issues. Yet da Vinci's notebooks have come full circle to the twentieth century in at least one respect: One of them is now owned by Bill Gates.



ILLUSTRATIONS BY JACK HARRIS/VISUAL LOGIC; PHOTOGRAPHS BY THOM O'CONNOR

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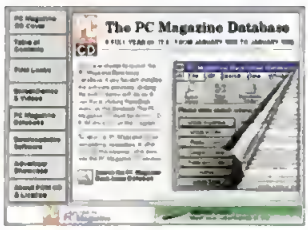


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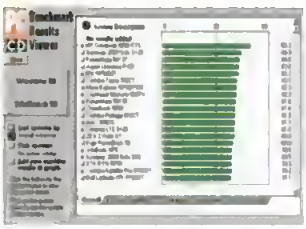
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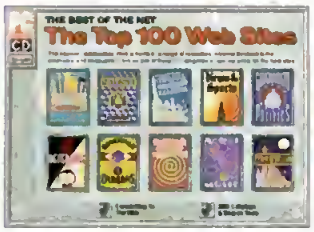
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FUTURE BUSINESS COMPUTERS

Light, mobile PCs and high-speed nets will foster "ubiquitous computing."

By Jim Seymour

They won't look much like today's machines, and we won't work with them exactly as we do today. But 15 years from now, personal computers by whatever name, in whatever size, at whatever prices, are still going to be among the central forces driving Corporate America.

From form factor to connectivity options to management and control of these devices and the electronic world to which they are connected, the "desktop PCs" of the year 2012 will be very different beasts from today's machines.

For one thing, the notion of "desktop" PCs will itself be largely obsolete. Though not all workers will carry PCs around for working away from their desks, fixed-location PCs that are too heavy to carry easily will be anachronisms. The PCs of 2012 will be much more like the notebooks of today in terms of size and weight.

A typical machine will probably still be no smaller than a piece of typing paper, 8.5 by 11 inches—mainly because we'll still be using keyboards for much of our data entry, and our fingers aren't getting any smaller. But these new-era machines will be much thinner and lighter than today's notebooks: less than an inch thick, certainly, and probably only 2 to 3 pounds. Their thin displays will be almost as large as the lid of each machine; again, physical form factors derive as much from human factors as from available technology, and we won't want to carry around PCs any larger than necessary. They will have brilliant color, high resolution, and probably "zoom resolution" features to allow users to zoom in on small details. Of course, this all hinges on the cost-effectiveness of such micro-thin components.

The CPUs in these wonders will run at much higher speeds than today's Pentium and PowerPC chips. Look for 128-bit or wider designs, running at 10 GHz or so. They will run at much lower voltages than today's chips, in order to keep the power supplies at an acceptable size and weight. Primary storage will probably still be magnetic, because of the ubiquitous and unremarkable use of data compression techniques, because the universal use of network storage will dampen our demand for vast in-the-box storage capacity, and because rust (magnetic oxide) is always cheaper than glass (optical) or other exotic systems. Remember bubble memory?

Vastly improved battery technology



Computers at Work: The Next Generation

Take a last look at the bulky system sitting on your desk: Tomorrow's PCs will be much smaller, with lots of local intelligence but central storage of most if not all applications. And your MIS department will oversee and configure all of it. Wireless LANs and WANs will be the norm, giving all of us access to ubiquitous computing. In addition, with improved speech recognition and greater processing power, you'll probably talk to your computer as much as you type.

plus greater attention to low-power displays, CPUs, and other components will mean most of us will use these machines without an AC-cord tether. Drop them into a "recharging tray" and in 2 hours they'll be ready to run for another 20 hours or so.

THE "VOICE PC"

Though we'll probably never stop carping about keyboard quality, by 2012 voice input will be so widespread that we'll talk a lot less about key travel and N-key rollover. Today's voice recognition systems generally demand discrete speech, in which/you/must/speak/like/this, allowing short pauses between words. "Continuous speech," in which you talk normally, requires much more computing power than is found in today's typical desktop PC—but that power will exist in abundance in the PCs of 2012, and voice input will be easy, natural, and accurate. For most input you'll simply speak normally, your words captured by a high-sensitivity noise-canceling microphone built into your PC. To record in very noisy locations, you'll probably use a tiny "ear mike," such as today's little-finger-size Plantronics microphone headset devices.

The use of speech recognition fits well with another important function of the PC you'll be using in 2012: It will also be your full-time wireless telephone, with deep integration between computer and telephony functions. No more returning to your hotel room at 1:00 A.M. to puzzle through a message garbled by a hotel operator. Your PC, which will always be turned on anyway, will play back your messages—having already auto-answered many of them, with its agents having handled others—when you get back to your room.

We can't look at 2012's business computers without including the by-then-commonplace "NCs," the successors to today's new and overhyped "network computers." The market will have long since adopted network computer–like devices for many traditional office functions, especially background tasks that do not demand the power of a true successor to today's PCs. We'll be way beyond a one-worker/one-computer ratio, with systems scattered all over our offices (and homes); these son-of-NC boxes will make that practical and affordable.

INSIDE

NETWORK COMPUTERS FROM COREL, IBM, AND SUN

FUTURE HAND-HELD DEVICE IDEAS FROM IBM

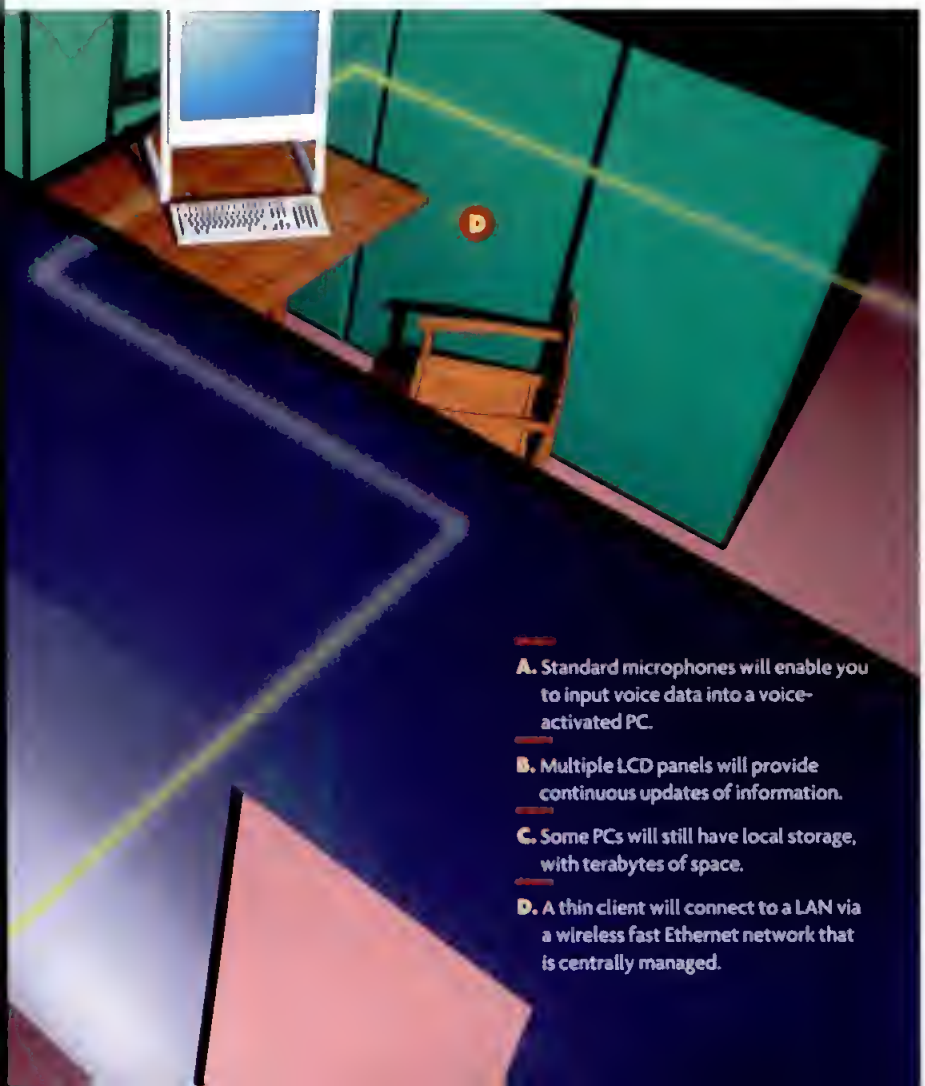
Sound farfetched? More revolutionary than evolutionary? We have no doubt that some people will still be using only marginally evolved versions of today's 40-pound desktop PCs, monitors, and keyboards—we hear every week from people who are still using PC-XTs, DOS, and Lotus 1-2-3 Release 1a. But the market, and our work habits, will have moved so far from today's paradigm that those tools will look as silly as an XT with a CGA display showing a 1-2-3 graph in pink, baby blue, and off-white does today.

CONNECTIVITY

In 2012, expect your PC to be constantly connected, wherever you are. Today's wireless LAN systems (such as Proxim's RangeLAN2) are teaching us about the usefulness of wireless LAN connectivity within the office. It turns out that wireless LAN connections aren't just for PCs in remote corners of the office—those famous hard-to-pull-wire-to places—but are also great for notebook users who want to wander throughout a building but still be connected to the LAN in seconds, if not continuously.

The data gurus already have a term for this wander-anywhere/stay-connected approach: ubiquitous computing. As odd as that notion may sound today, in 15 years it will be commonplace. Indeed, we'll laugh at the idea that the norm for networking PCs could be pulling wire and plugging in. Today's limited wireless-LAN transmission speeds and operating distance will be distant memories; with few exceptions, only servers will be physically connected via cabling.

Outside our offices, we'll rely on something like Metricom's Ricochet broadcast system to keep connected. That constant connectivity will be important, because increasingly, we will do our work away from a central office. Indeed, many expect the notion of a central office, full of dedicated workspaces for employees, to be itself a victim of the years between now and



A. Standard microphones will enable you to input voice data into a voice-activated PC.

B. Multiple LCD panels will provide continuous updates of information.

C. Some PCs will still have local storage, with terabytes of space.

D. A thin client will connect to a LAN via a wireless fast Ethernet network that is centrally managed.

2012. Instead, "hoteling" arrangements, in which workers will visit a central facility at regular but not daily intervals, seem likely to replace many of today's dreary rows of cubicles. (Will Dilbert approve of the change? Of course not.)

The speed of these network connections will be greater, probably much greater, than today's common 10 Mbps, uncommon but welcome 100 Mbps, and coming-soon "Gigabit Ethernet." Predicting actual speeds is getting out on thin ice, but we'll say gigabit-plus intra-office LAN communications will be common, and truly high-speed links will be available for those who really want them. Outside the office, we may have to suffer along at only 100 Mbps or so.

MANAGEMENT

The key issues for managing PCs in corporations over the next several years will be control, standardization, and lifetime cost. (Hmmm: Those sound like today's hot buttons. . . .) Efforts by the Desktop Management Task Force, particularly its evolving Desktop Management Interface (DMI) standard, are focusing on remote "manageability"—in other words, MIS's ability to control, configure, and reconfigure your PC remotely. This sounds Strangelovian, and it makes a lot of today's PC users uneasy.

Will the MIS people be able to detect that you have reconfigured your PC, and in a nonstandard way? Yes, if it's possible for you to reconfigure it at all. Will they be able to tell that you've installed unauthorized software titles—perhaps illegal copies of programs you bought or otherwise acquired for your home machine—on your PC at work? Yes again—if, in a limited-local-storage world, there's a way for you to put those programs on the machine in the first place. Will MIS be able to reconfigure the machine completely, delete unauthorized programs, and restore it to the form it was in when that nice young woman from MIS delivered it to your desk? You bet.

Uncomfortable? Remember that it's that same technology, already moving into many widely used network management products, that also lets MIS "push"-install new software releases on your machine rather than sending around disks or a CD-ROM or, worse, requiring a tech to come fiddle with your machine for an hour. Ditto on upgrading your system's BIOS code. The technology also lets MIS survey your company's installed base of PCs, watch for usage patterns, and make sure there are enough concurrent-use software licenses to keep you and the company legal. And it lets you communicate with coworkers a lot more easily, by being able to send messages and share files without worries about which version of what the other person is using.

So, creepy or not, DMI and its vastly more powerful and controlling successors are going to be very important. We think you'll soon become used to the idea of MIS overseeing your PC. And given the much more complex world of wireless connectivity and ubiquitous computing, you'll probably appreciate how many burdens it takes off your shoulders.

Your PC will become an appliance, not making nearly the same demands on your time as today's PCs.

ZERO ADMINISTRATION

Not to be outdone, Microsoft also has an initiative that not only takes the burden of overseeing your PC from you but removes much of it from the network administrator as well. Microsoft's Zero Administration plan aims to minimize the time users and network administrators spend under the hoods of their PCs by automating labor-intensive tasks, such as installing and updating software.

Under this initiative, during a networked PC's boot-up, it would check with the server, the office intranet, or the Internet for operating-system updates and would then download and automatically install the applicable ones. It could automatically upgrade software drivers for networked printers, graphics cards, network cards, modems, and other peripherals without input from the user and with relatively minor input from the network administrator.

An Automatic Desktop feature would provide workstation users with all available applications, using a single installation routine. Under the plan, users would also be able to "reflect" personal data to the server, a feature that would allow them to change workstations or log on to the server remotely and end up with the same personalized desktop, applications, and personal data.

CENTRALIZED SUPERVISION

The Zero Administration initiative gives network administrators far more leeway in controlling the network as well as individual workstations. The administrator would be able to lock down the network or fine-tune access rights for individual desktops from a central location.

Another key point of Zero Administration is the implementation of Microsoft's new Active Platform, a software development platform for intranet and Internet applications. The Active Platform has three key components: the Active Desktop, Active Server, and ActiveX.

The Active Desktop offers software developers language-independent scripting, new dynamic HTML technology, and other tools for designing applications that will run on multiple operating systems.

Active Server provides additional support for developing Web applications on Windows NT–based servers. The ActiveX component permits software in different languages on different operating systems to communicate within a single machine and across a network.

According to Microsoft, the functions described in the Zero Administration plan will be available "to varying degrees" in future versions of Windows 95 and Windows NT Workstation and will be available in the upcoming Windows NT Server 5.0. You can find additional information about Zero Administration on Microsoft's Web site.

THE INVISIBLE PC

At first glance, these changes may seem less than welcome, even steps backward from the Wild West of today's PCs. In fact, though, they won't be such a big deal for you. Your PC will have become simply an appliance, not drawing nearly the same attention, nor making nearly the demands on your time for grooming and maintenance, as today's PCs.

It will have become part of the background noise in business—an information appliance about as remarkable as, say, today's fax machines and office copiers.





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EMERGING BUSINESS COMPUTERS

NCs GO UP AGAINST THE PC

Network computer vendors offer many variations on the single-minded theme of reducing the soaring cost of PC support. **By Tony Pompili**

Alluring to IT departments, network computers (NCs) are advancing on the desktop scene with the promise of lower prices and operation costs. Traditionally targeted to terminal emulator markets, NCs are making their push on the basis of horsepower that can run a richer array of applications than terminals do, including Web browsers, Java applications, and even Windows programs. Although this expanded support is standard in most of the newer NCs, implementations differ subtly depending on how vendors envision the evolving market.

To a greater extent than terminals and a lesser degree than PCs, NCs use networks and servers rather than local hard disks or other storage devices to load applications and data. In the absence of hard disks and other hardware, NCs are potentially easier to maintain and replace than PCs.



Corel's Video Network Computer is optimized for Java and for mobilized use.

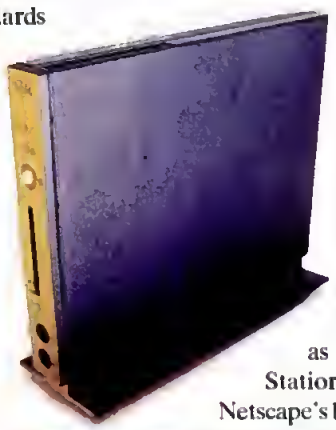
Here, we look at NCs from three vendors we think will be major players in this nascent market: IBM Network Computer Division's Network Station, Sun Microsystems' JavaStation, and Corel's Video Network Computer. Each company is hoping that its newest offering will appeal to corporations and other large organizations gravitating toward NC technology, and to any that want to decrease hardware support and maintenance costs over the long term.

THE NC DEFINED

Network computers probably resemble each other more than they differ. All the NCs in our group have built-in network adapters and serial, parallel, mouse, and keyboard ports. Some supply a keyboard and a mouse as part of the base configuration, and some offer an optional monitor.

Regardless of the manufacturer, these NCs are the same in terms of installation and maintenance. To install, you simply connect the NC to the network and boot it. Then you can specify the applications that users can access by making a few changes to a centrally maintained user profile. Should the NC fail, you just swap it out for another unit (since most configuration information as well as the user profile is stored centrally). Power up the new machine and you're ready to go. No data restoration or other system customization is necessary, since the new unit will download the same setup configuration that the failed NC used during its first boot.

To be fair, we should mention that NCs have been around for years from other companies, such as Network Computing Devices (NCD), Tektronix, and even Hewlett-Packard. But these devices have mostly been replacements for dumb terminals. The newest and more interesting products attempt to run a greater range of applications, from terminal emulators to Windows programs to emerging Java applications. NCs are also meeting basic, agreed-on standards outlined in the Network Computer Reference Profile (an initiative spearheaded by Oracle). Like the Multimedia PC (MPC) specification, the NC Reference Profile describes general operating parameters for NCs, such as basic networking procedures on TCP/IP, the Ethernet protocol, and supported file formats.



IBM's Network Station will run the Java VM, as well as 5250 and 3270 emulators.

BIG BLUE, LITTLE BLUE

IBM's vast experience with large networks is apparent in its new **Network Station**, a system designed for short-term terminal emulation and for the use of Java applications in the long run. Codeveloped by NCD, the Network Station will include high-performance emulators, such as AS/400 5250 and MVS/VMS 3270. Expecting growth in the Java arena, IBM is also including the Java virtual machine, software that runs Java applications.

The Network Station runs on a 33-MHz PowerPC 403 CPU with 8MB of memory (expandable to 64MB). Like its competitors, the system comes with a built-in network adapter, either Ethernet (10 Mbps now but expanding to 100 Mbps later this year) or Token-Ring. The unit also has keyboard, serial, parallel, and mouse ports.

The Network Station uses a streamlined operating system, the Network Station OS, for loading network stacks and basic I/O and GUI features. Like other NCs, the unit loads much of the OS from the server during boot-up, so little of the OS resides in the unit's BIOS. And like its competitors, IBM uses standard TCP/IP-addressing applications, such as BOOTP, to assign IP addresses and to locate boot servers.

Since the Network Station loads its OS and applications from the network, it is at the mercy of the network's bandwidth, like any NC. IBM expects the full boot process to take roughly 2 minutes, depending on OS options and the applications loaded. To minimize boot time by reducing the amount of startup code transferred across the network, IBM will later offer a PC Card flash card (the unit features one Type II slot) and store the OS on-board.

On the software side, in addition to using the Java virtual machine, the Network Station will include emulator applications that will run directly on top of the unit's OS. IBM believes this approach will provide better performance than running the emulators as Java applets. The Network Station will also be preloaded with Netscape's browser Navigator 3.0, to provide users with access to Web servers





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The Future of Hand-Held Devices, IBM Style

By Carol Venezia

In this, our fifteenth-anniversary issue, we've devoted a lot of space to discussing the future of high technology. Some of the predictions we've made in these pages may be difficult to envision coming true. But after we spoke with IBM about what's cooking at its Almaden research center, the vision became clearer.

We had the opportunity to delve into the mind and the ideas of IBM Fellow Dr. Ted Selker, who heads the User Systems Ergonomics Research (USER) group at IBM's Research Division in San Jose, California. The USER group comprises about 20 people (half of them students from Stanford and other universities, and half of them IBMers) who research and develop ways of making interfacing with computers more intelligently planned, useful, and intuitive. A great example of this group's work is IBM's TrackPoint pointing device, which Dr. Selker invented.



The Room with a View's viewboard (top) and the diminutive Palm PC 110.

The products discussed here may seem fantastic, but they are all based on the same premises: Technology should be useful but unobtrusive; it should have a distinct purpose and fulfill a need. And it should do all of this as effectively and easily as a ballpoint pen performs its task.

TECHNOLOGY TO GO

The advent of the Windows CE hand-held PC may have brought us closer to truly useful mobile computing, but IBM's vision of a wallet PC takes this idea one step further: A typical trifold wallet is outfitted with a miniscanner, a display area, and a keyboard. It's a PC, pager, Web browser, PIM, PDA, and more, all in your back pocket. The wallet would also offer a "chameleon card"—a single card with a programmable magnetic stripe that would take the place of all of your credit cards.

Another idea that qualifies as useful and unobtrusive technology to go is the electronic carbon-copy pad. This product takes an interesting approach to mixed media: You give someone a note you've scribbled out (like one of those notes you've scribbled on napkins in restaurants), but you also have an electronic record for yourself. This process greatly increases the *tangibility* of computer use, a feature that is often lacking in today's PCs—one of the major reasons why many consumers find PCs unapproachable.

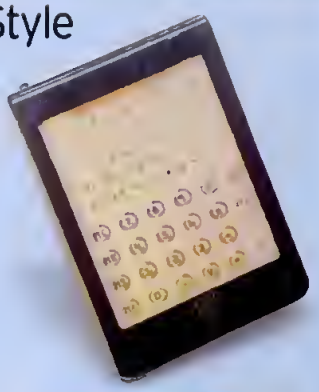
Another portable idea from the USER group involves IBM's Palm Top PC 110, a miniature 486-based PC that's been a great success in Japan. The version we saw adds two intriguing features. First, there's a clip on the back, so you can attach the fully functional, Windows 95–compatible PC to your belt loop. Second, the display panel is hinged and opens in the back, so when you return to your desk, you can project the screen's image onto the wall. A proposal currently on the table from the USER team is for an inexpensive tablet-size PC for schools. It would replace the paper notebooks that grade-school children carry.

This PC (about the size of a paperback book) has a touch screen and an infrared transceiver, which can be used to download assignments nightly, upload the student's work in the morning, and correct it. The education PC's keyboard is another unique feature: It's LCD-based, so you can change it from letters to numbers to symbols, depending on the task.

A ROOM WITH A VIEW

Perhaps the most fascinating prototype that we saw was the Room with a View. This product (a working model of which currently resides in Dr. Selker's office) addresses two necessities of human nature: to be oriented (why do you think you spend so much time arranging those Win 95 icons on your PC's desktop?) and to be productive.

The Room with a View operates something like a virtual-reality office. Instead of having bookshelves in your office, you'd have a projection of those shelves and their contents on the wall. If you wanted a book from the shelf, you'd simply pick up your "viewboard" (a high-resolution LCD-based tablet), point it at the image of the book on the wall, and retrieve the book by shooting it with the viewboard's built-in laser. The information contained in the book would now be right in front of you, in an easy-to-use format.



The education PC's display keyboard can change with the assignment.

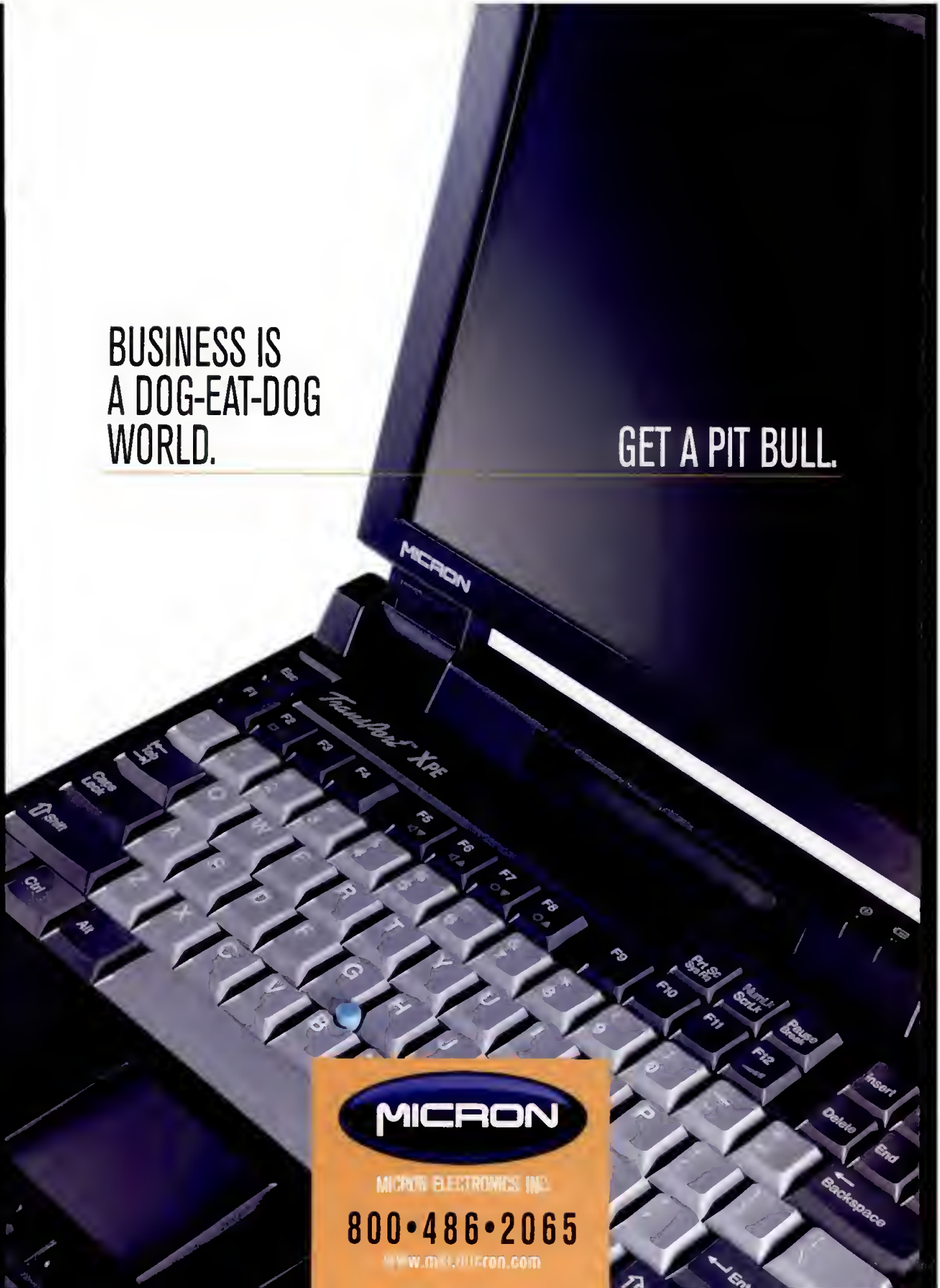
TRACKPOINT ON A STICK

The remote control is a useful device, but it's also an idea run amuck. Remember when you had just one remote for your TV? Well, now you have five, and they're all gigantic. Out of this confusion came the idea for a universal, TrackPoint-based remote.

This remote control would rely on a GUI with pie-shaped menus instead of on physical buttons to perform tasks, like changing channels or adjusting volume. You would make selections through specified, easy-to-remember movements. But the beauty of it is that you'd need only one remote for everything, and it would be easy to use and no larger than a good Cuban cigar.



Electronic Post-It notes (left), the wallet PC, and the TrackPoint remote.


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Built-in stereo speakers and microphone
2 infrared ports, 1 front, 1 rear
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Management Pak: MPEG Arcade Player, ASAP WordPower, Quicken SE, SPRYNET Internet trial membership
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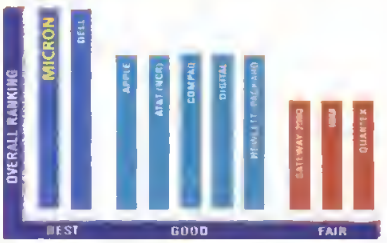
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across the Internet or within an intranet.

For accessing Windows applications, IBM (like its competitors) is relying on third-party products rather than offering its own emulator. One choice is NCD's WinCenter Pro, a software package that combines remote-control technology with a multiuser Windows NT server implementation. Applications run on the remote Windows NT server, with keyboard and mouse commands and screens being the only data sent between it and the NC.

For Net surfing or limited Windows apps use, an NC might fit. But for power users, the PC still serves best.

The Network Station also needs a server application to which it can talk, so IBM provides its Network Computer Manager (NC Manager). This application runs on a variety of IBM host platforms, including RS/6000, AS/400, and S/390. NC Manager also interfaces with user management software native to the platform, so system administrators can use their own software to create NC user profiles. IBM expects to have a Microsoft Windows NT Server version of the Network Computer Manager available later this year.

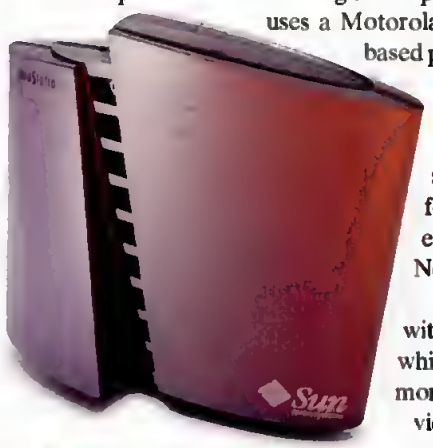
For hard-core IBM shops, IBM expects to have coaxial and twinaxial versions of the Network Station available later this year. The system's 8MB version, available now, will cost under $700 (street price) with keyboard and mouse.

HAVE A LITTLE JAVA

Sun Microsystems, the mover and shaker behind Java, is so committed to Java compatibility that it built its **JavaStation** around Java from the ground up. Admitting that no major Java applications yet exist, Sun notes that over 400 software developers have expressed interest in developing such programs, which the company says indicates Java's popularity as an OS-independent applications development language. From terminal emulators to the browser and applications, if it runs on the JavaStation, it's written in Java. Available now, this machine uses Sun's 100-MHz microSPARC II processor. It includes the standard I/O ports as well as speaker and headphone jacks, and it runs with 8MB of RAM. It also comes with an Ethernet 10Base-T adapter, which will be upgraded to 100 Mbps by mid-1997.

At the root of the JavaStation's software is Sun's network computer operating system, JavaOS. On top of it runs the Java virtual machine. Sun also ships a user interface called Hot-Java Views, a GUI for running applications and configuring the machine. Hot-Java Views (written completely in Java) also includes a set of Java applets, such as an address book and e-mail. Also pivotal to the JavaStation's strategy is HotJava, a fully Java-based Web browser.

Like IBM's Network Station, the JavaStation needs a server component during boot-up to download the OS and applications. At this time, the server process runs only on Sun servers, but Sun expects third-party developers to port the server software to other platforms. To speed up the OS boot process, Sun is thinking of offering a version of its system with a built-in OS for local loading.



Sun's long-awaited JavaStation was designed to run Java apps, from JavaOS to HotJava Views.

Adhering to the Web standard, Java applications can load not only from Sun servers but also from any HTTP server. Currently shipping, the JavaStation is $742 (list price) with mouse, keyboard, and 8MB of RAM.

COREL AND THE PERFECT APPLICATION

Corel, popular software vendor and vocal proponent of Java applications, has designed a network computer optimized to run full-bore Java applications. Still in development, the **Video Network Computer** (VNC) complements Corel's forthcoming Corel Office for Java, a business productivity software suite that will include streamlined Java versions of WordPerfect, Quattro Pro, and Chart.

Similar outwardly to the Corel Video Console, the VNC includes the usual I/O ports as well as speaker and microphone jacks. It also provides two PC Card slots. Taking a more aggressive approach to mobile NC use than its competitors, Corel plans to use the slots for connecting mass storage devices, such as hard disks, so that users will be able to carry the notebook-size NC between office and home. At home, where the network connection is probably slower, end users can plug a hard disk into a PC Card slot and use it to download the OS and applications more quickly. Through V.34 dial-up networking via an ISP, users will still have the flexibility to load Java applications from a variety of Internet servers.

Corel plans to ship the VNC with 32MB of base memory (expandable to 64MB)—significantly more than IBM and Sun—because it considers this amount preferable for running Java applications. The VNC uses a Motorola MPC 821, a RISC-based processor with a built-in V.34 modem chip set, which further supports Corel's positioning of the VNC for mobile use. Corel expects to use HDS's Net OS with the unit.

The VNC also comes with a video camera, which hangs over the monitor to allow for videoconferencing. The camera is a high-compression digital model, and it takes care of compression functions itself instead of relying on the CPU.

The Corel VNC is expected to cost between $500 and $700 (street) and should be available in the second quarter of this year.

THE BOTTOM LINE

With this generation of NCs shipping in the coming months, it should become clearer whether they have a place in your organization. For Internet or intranet surfing, basic terminal emulation, or limited use of Windows applications, NCs might be a perfect fit. Then it's a matter of choosing whose NC architecture best fits into your network and applications environment. But if you're a power user, your trusty PC will still serve you best—for now. □

FUTURE HOME COMPUTERS

The "information furnace" will power computing in every room—and beyond.

By Bill Howard



In 15 years, home PCs will be just like peanuts: You won't be able to stop with just one. And speaking of food: In 10 to 15 years, your refrigerator may in fact have a flat-panel display built into the door.

Here's what's likely for PCs in 2012: There will still be a desktop-style PC somewhere in the house—maybe several of them. But there'll be a wide variety of other devices able to function as PCs.

The big television set in the living room or den will serve as a computer display, and vice versa. Right next to your main TV will be a PC that can function as a controller for all your home stereo and home theater components. In addition, you'll have a VCR that you'll actually know how to program—no more blinking *12:00...12:00...12:00....*

In upscale homes, a PC will be present in every bedroom. Somewhere, possibly tucked away in the basement or where the phone lines come in, there will be a bullet-proof, high-reliability PC that will be the brains of the house. It will control the burglar alarm, the phones, the heating and air conditioning, the lighting, and the sprinklers. It may also act as a central file server for other household PCs, provided that this doesn't degrade the reliability of its core security functions. Some wags call it the "information furnace," a play on "information appliance," because it's likely to reside in the basement.

There will be a network connecting all the PCs and computer devices in the house. In new houses, it will consist of network cable (essentially high-grade phone wire), because laying the cable is relatively cheap while the house is being framed. But in most existing houses, it will consist of either radio-frequency wireless or wiring already in the house, most likely the AC lines but possibly the cable for your cable TV. Rewiring a house costs thousands of dollars, and that won't get cheaper over time.

TYPES OF PCs IN THE HOME

As we noted, there will be several types of PCs in the home, all tailored to different uses. Most will be smaller and more compact than today's PCs, with fewer wires connecting the pieces. It's likely that flat-panel technology will be competitive in quality as well as price with CRT technology: The display will be unobtrusive. (You really could hang it on the wall, embed it in a desktop, or seal it in the refrigerator door.) The PC itself won't be much bigger than today's notebook PCs and might be even more compact—so compact that it could be integrated into either the display or the keyboard.

The TV display will likely have an elongated ratio of 16 inches wide to 9 inches high—close to that of wide-screen films—rather than the 4:3 ratio (equivalent to 16:12) of today's TV and computer screens.

The *big-screen PC/TV*—à la today's Gateway 2000 Destination—will encourage collaborative computing in the family: Mom will use it to help Junior with his homework, and there will be more multiplayer games, much like today's You Don't Know Jack. But this won't be the PC you'll use to balance your checkbook (at least not if you have nosy neighbors and might forget to draw the blinds).

There will still be a *desktop PC* that

INSIDE

APPLE'S MESSAGEPAD
IBM'S VOICE-CONTROLLED HOME DIRECTOR
PANASONIC'S INTERNET PHONE
WEB TV

The Home Of the Future

As PCs become more affordable, there will be one in every room of the house. What will you do with all of them? Here are just a few ideas: In the living room, you can use the PC to categorize all of your CDs and movies, or you can lock out unsuitable TV programs. The home control-center monitor in the kitchen will keep an eye on your vacation home and regulate the temperature, lights, and security system of your current residence. The PC in the bedroom will store all of your photos digitally. All these systems will be networked via the "information furnace," a server kept out of sight somewhere, probably in the basement.

may look a lot like a notebook PC. All the internal components will be downsized. To expand, you may add an external wedge, or "slice," to the unit. Of course, manufacturers will long since have resolved configuration hassles.

There will be a *kitchen PC* that rolls into one box all the functions now on one kitchen counter in many homes: phone, answering machine, security-alarm panel, 9-inch TV. It will likely also be a real PC, assuming that a rock-steady operating system is running it. Nice as Windows 95 is today, you wouldn't completely trust it to run the burglar alarm, would you?

The telephone (unquestionably cordless) may be a *telephone/PC/organizer* in its own right. Lift the handset from the wall and it's a wireless phone. Walk down the block with it and the phone switches to the cellular network, but airtime will cost pennies a minute, not the 50 cents or a dollar you pay now. This handset may also control lights around the house and some functions of your kitchen PC burglar alarm. It might have a bar code scanner built-in to let you take a household inventory or even create a shopping list.

There almost certainly will be *car PCs*. Right now, high-end cars have more than two dozen microprocessors, and last year Intel announced an initiative for a car computer. The device will perform door-to-door routing (a feature already available in Acuras, BMWs, and Oldsmobiles, but for $2,000 to $3,000) to help you find a hotel or your favorite restaurant chain while en route. If you're in an accident, it will call for help automatically. The problem today is that the handful of in-car guidance and security systems are walled off from computers not in the car. They don't link up to your home computer. By 2012 they will.

FUTURE ASSUMPTIONS

There are also a number of technologies that will progress in one of a handful of ways, but we don't know for sure which route they will take. For example:

• **Internet link provider.** Who will provide high-speed access to the outside world?



Will it be the phone company (now considered arrogant but technically savvy by many), the cable company (now considered arrogant, period), the satellite service provider, or some dark-horse company, such as the electric company? (Don't laugh—it already owns the utility poles and could very easily string a data line on those poles.)

• **Local storage.** Whether mass storage remains local (son of son of DVD-RAM) or is delivered on demand from an information server is anyone's guess. We may go from no CD-ROM drives to fast CDs to rewritable CDs and DVDs, back to no CDs or DVDs at all.

• **Flat-panel technology.** Today LCDs are dominant, but it appears that gas-plasma technology has more promise for displays bigger than 20 inches diagonally. In 2012, who knows? CRT technology may still be with us, too, but if this method is to survive, the tubes will have to get shorter. Today a PC monitor is roughly 1 inch deep for every inch of screen diagonal (TVs have slightly less relative depth), so a 17-inch display is 17 inches deep, plus or minus an inch.

• **Alternative input devices.** The keyboard and mouse will likely stick with us. Touch screens may gain popularity, especially in PCs in the kitchen, where people of all ages will be interacting with the unit. We'll probably have enough computing horsepower for real, continuous speech recognition, too. You might even carry a handheld PDA that performs on-the-fly translation when you're traveling internationally.

SO WHAT CAN I *DO* IN 2012?

Hardware is cool to techno-weenies, but most people want to know what useful tasks they can actually do with it. Odds are, you'll still be typing documents and entering numbers in spreadsheets. Consider the following possibilities. Some are only a few years away.

In the living room or entertainment room, your PC will categorize all your CDs and DVD movies, if they're actually physical objects you keep in your house. (Maybe there will be so much bandwidth you'll be able to order up any song or movie on demand. We'll see.) You'll be able to program your 500-disk CD/DVD changer to play children's music in the morning, then jazz for the next 2 hours. (Each disk will be encoded with likely categories, or you'll be able to choose your own.) You'll be able to lock out TV shows you don't want your kids to see, and the system will be much more sophisticated than the TV industry's labels for three or four age levels. You'll subscribe to one of hundreds of ratings services—you'll pick the one you feel most typifies your family's tastes—and it will rate all the shows. This is an example of how technology can be more useful if it's in the hands of private groups than if the government controls it. Of course, you won't *have* to use any ratings service.

Home automation will be a hot item: lights, security system, sprinklers, heating, and air conditioning. You'll even know if you've left the garage door open. All this is possible right now in high-end "homes of the future," but it costs $100,000 to implement. We're talking about something that would cost only a few dollars for each sensor. Since every PC will also be a TV, you could put a TV camera at the front door to watch for the delivery man or screen visitors. Another camera could go in the backyard to keep an eye on the kids.

The PC 15 years hence will let you work more quickly. How you use the found time is up to you.

If you have a vacation house, you'll be able to monitor it remotely for break-ins or furnace failure. Again, that technology exists now, but it will become affordable and available to anyone who has a PC.

You'll have enough cheap storage to digitize all your still photos and store them locally or in some huge information warehouse. Video camera technology will switch from analog to digital recording (a few cameras already are digital, but they're $2,500-plus). And you'll be able to capture movies to your PC's hard disk and edit them just as TV news shows do now. This will happen far sooner than 2012. By then, virtually all still cameras will be digital.

Most every PC will have a videoconferencing camera. Use it on the day you're working at home to dial in to your workgroup's daily meeting. Use it at night or on the weekends for talking to relatives and to children away at college. Already there's a surge of PC purchases by the middle-class and affluent elderly, all of whom have the same lament: "My kids never write and they hardly ever call. But they answer e-mail. And with video cameras, I can see what the grandchildren look like." Who knows, maybe there will even be an on-the-fly retouching feature that will give you a "shave" and paint a button-down shirt and tie onto your sleepy frame, actually still sporting ratty pajamas and yesterday's beard. What sounds like a joke today could be commonplace in 2012.

As America ages, you can expect more medical-information databases and self-diagnosis programs. With that video camera (much higher-resolution than today's), your doctor might even check out that skin rash remotely: Allergy? Poison ivy?

Today, education motivates many PC purchases. Similarly, tomorrow we're likely to see customized edutainment programs for tutoring children in areas where they need more help. The tutoring may well take place via an online service. It could even be one-on-one with a remote tutor, or one-on-five (with each child seeing only the tutor and the tutor seeing each child).

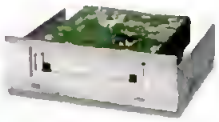
There will also be big sociological implications. In the 1930s, the government decreed that everyone deserved access to telephone service, and recently there was similar discussion about PCs. Nothing much came of it, because it's one thing to subsidize a $50 phone and $10-a-month service; it's another to fork over $2,500 per PC. But as prices drop below $1,000 for the basic PC, and below $500 for devices whose intelligence resides more at the far end of a phone or network cable, perhaps we will wind up providing universal PC access.

Much of the stigma surrounding working at home has gone away, and that shift can only continue. As computing devices and peripherals get smaller, more people will be able to work comfortably out of their homes without allocating separate rooms or having their equipment take over the living room of a small apartment.

One thing won't change: In 2012, there will still be only 24 hours in the day, and you'll need to sleep for about 8 of them. The PC 15 years hence will let you perform tasks quickly and more intelligently. How you use the found time is up to you.

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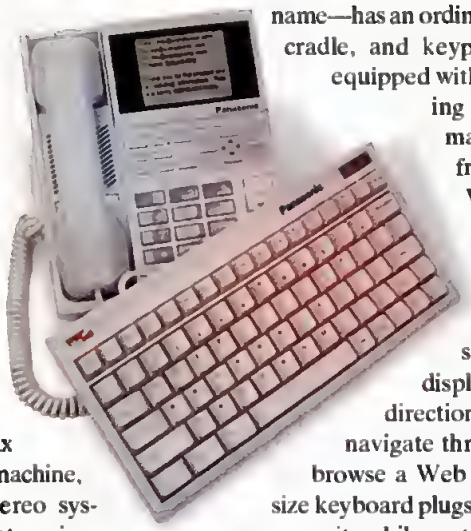
EMERGING HOME COMPUTERS

DECISIONS, DECISIONS

Increasing convergence of technologies and growing access to high-speed networks is leading to a parade of new computing devices. **By Cade Metz**

Don't look back, Martha Stewart: The PC may be gaining on you. After years inside an off-white plastic case next to the family file cabinet, PC technology is gradually moving into the kitchen, the living room, and ordinary domestic life. While an antiquated Intel processor is likely running your microwave oven, leading-edge computer designs are on the verge of transforming your household appliances and easing your everyday existence.

Even now a home PC such as the Toshiba Infinia 7200 can integrate your fax machine, answering machine, telephone, radio, stereo system, and television into a single unit ("Home PCs: High Style, High Speed," December 17, 1996). The general public isn't watching "ER" every Thursday night on the Infinia's 17-inch screen—much less the 31-inch display of the Gateway 2000 Destination—but the domestication of the PC is only beginning. Computer technology may soon be as prevalent in the home as running water and electric light.



With Panasonic's Internet phone, you can send e-mail, cruise the Web, or simply call your home.

DIBA'S INFORMATION APPLIANCES

Farzad Dibachi (a former senior vice president at Oracle) and Farid Dibachi (former CEO and founder of Wavetron Microsystems) recently founded Diba Corp. in an effort to bring PC technology to the masses. This Menlo Park, California, start-up is currently developing a series of **Information Appliances**—devices that blend the potency of a PC with the simplicity of a toaster or a blender. Though these self-sufficient units contain their own processors, memory, and integrated software, they'll be as affordable and accessible as common household appliances.

The first of these devices—a telephone that provides basic Internet access—grew from Diba's partnership with Panasonic. This modest unit—which is still without a name—has an ordinary phone receiver, cradle, and keypad, but it is also equipped with an LCD for sending and receiving e-mail or perusing text from the World Wide Web. Buttons offering typical e-mail controls (send, reply, forward, delete) reside just beneath the display, as does a set of directional keys that let you navigate through a message or browse a Web page. A standard-size keyboard plugs into the rear of the unit, while a standard phone line connects you to the Internet.

Some units will come preconfigured for a particular ISP (Internet service provider); you can also choose your own. The phone won't require an external modem, additional software installation, or convoluted configuration procedures. After plugging the unit into an electric outlet and a phone jack, you'll have a traditional telephone with traditional telephone functions (Caller ID, redial, and so forth) as well as an e-mail interface. A prototype of this product debuted at Fall Comdex, and it should be available by the end of 1997.

Diba is also developing a PC that attaches to the bottom of a kitchen cabinet and serves as an automated cookbook. With a built-in CD-ROM drive, **Diba Kitchen**—as the unit's prototype is known—conveniently stores recipes, menus, nutritional information, and calorie counts.

Though Diba's device is still weeks away from reaching the market, Brother International Corp. of Somerset, New Jersey, has already shipped a product—the **Kitchen Assistant**—that fills virtually the same niche. Brother's Kitchen Assistant ($350 street), a digital database of recipes, is slightly larger than a sugar canister (6 by 6 by 8.5 inches) and weighs but 2 pounds. That 2 pounds includes an external keyboard and an integrated thermal printer, which allow you to input personal recipes or print shopping lists. The unit ships with 75 preloaded recipes and has two expansion slots for supplementary cookbook cartridges.

Using six function keys and a classic LCD, you can select a recipe by category (appetizer, entrée, dessert) or primary ingredient, then peruse it, print it out, and check its nutritional makeup if it's a preprogrammed recipe. The unit also provides five separate timers, a menu planner, a glossary, and a "reverse recipe" feature (a means of locating dishes that use only available ingredients).

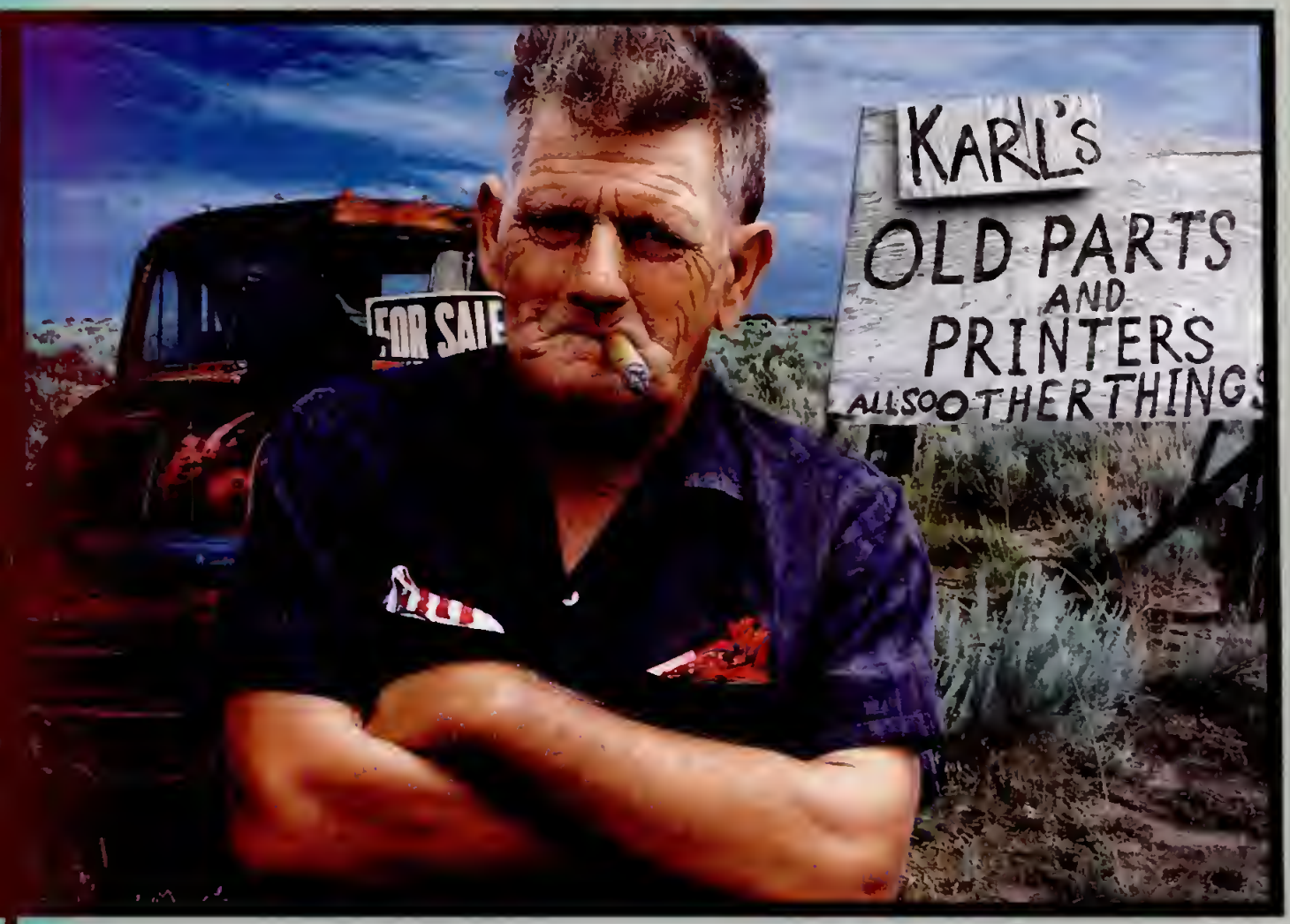
Brother's Kitchen Assistant runs on AC power or AA alkaline batteries and uses a 2.25-inch roll of paper. Brother sells additional paper rolls (three for $14.95), additional memory ($39.95 per 128,000-character card), and an eclectic selection of recipe cartridges ($29.95 each). Never again will you lose your favorite recipe or render it unintelligible by spilling the chicken mole on it.



Brother's Kitchen Assistant stores all of your favorite recipes and will even print a shopping list for you.

The final member of Diba's Information Appliance triumvirate is a variant of the oft-discussed Internet TV. After entering partnerships with both Samsung Electronics Co. and Zenith Electronics Corp., Diba will deliver a series of television units that furnish Web browsing and e-mail access.

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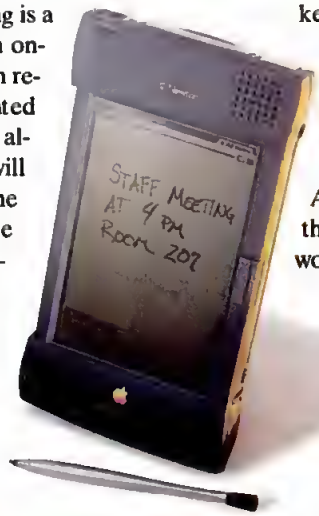

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Phaser 300X


Phaser 550

The initial Samsung offering is a 27-inch **Internet TV** that uses an on-screen keyboard, a push-button remote control, and an integrated 33.6-Kbps modem. Units are already shipping in Korea and will arrive in the United States in the second half of this year. The Zenith unit—called **NetVision**—will ship with a trackball remote control, a built-in modem, and an Ethernet port for use with forthcoming cable modems. By the time you read this, the latter design should be selling in retail outlets. Wireless keyboards will be optional.



Apple's MessagePad recognizes both print and cursive character input.

I WANT MY WEB TV

In a separate venture, Mitsubishi Consumer Electronics America has teamed with ViewCall America to develop and sell a similar product—the **DiamondWeb TV.** Due for release this summer, this Internet TV uses ViewCall's On-TV service and technology from Microware, Motorola, and Spyglass to provide e-mail, Web browsing, Java support, TV-based HTML extensions, and bookmarks, as well as parental control features.

Of course, several vendors are shipping units that offer Internet access by connecting to extant televisions. Nascent products from Philips Consumer Electronics and Sony Electronics use technology from WebTV Networks, a start-up company based in Palo Alto, California. The $329 **Philips Magnavox WebTV** and the $349 **Sony WebTV Internet Terminal** will immediately connect you to the Internet using a standard television and a standard phone jack: Just dial WebTV's toll-free number via a button on your remote control, enter your credit card number, and choose a local access point. A $19.95 monthly access fee gives you Web browsing and five separate e-mail accounts.

With each of these WebTV products, a simple front end links you to an e-mail interface, a predefined bookmark list, a search engine, and several celebrated Web sites (CNN and MTV, among others). The devices themselves contain 33.6-Kbps modems and connect easily to standard PC keyboards. You can also use the on-screen virtual keyboards, but wireless keyboards are available from both vendors ($79 for the Sony keyboard, $69.95 for the Philips keyboard).

Moreover, Sega of America—that giant of the consumer gaming world—is now offering the **Sega Saturn Net Link,** a $199.99 unit that integrates a 28.8-Kbps modem and proprietary Web software. When coupled with the Sega Saturn gaming system (also $199.99), this access tool provides e-mail, Web browsing, chat-room access, and network game playing. Its browser is HTML 2.0–compliant and uses an on-screen or standard keyboard. Sega offers one month of free Internet access and charges $19.95 per month thereafter.

PDAs

Even the Rolodex and the yellow legal pad are giving way to PC devices. For years, PIM (personal information manager) software, such as Lotus Organizer or Microsoft Schedule+, has equipped PC users with digital calendars, contact databases, daily planners, and to-do lists. Subsequently, PDAs (personal digital assistants) have offered similar applications from portable, palm-size hardware.


Web sans PC: The Sega Saturn Net Link, Sony WebTV Internet Terminal, and Philips Magnavox WebTV.

U.S. Robotics' **Pilot 5000,** a finalist in our 1996 Technical Excellence Awards (*PC Magazine*, December 17, 1996), is a 5.5-ounce unit that's about the size of a box of playing cards (0.6 by 4.6 by 3.1 inches).

This diminutive device has succeeded where other such machines have failed, because it doesn't promise more than it can deliver. And those functions that it does tout, it performs extremely well. It offers the four typical PIM applications (a date book, an address book, a to-do list, and a memo pad) while adding a calculator and several security features. With the unit's stylus pen, you can input data via an on-screen keyboard or an on-screen writing pad. The latter responds only to a set of predefined symbols (called Graffiti alphabet), but most of those symbols mirror everyday alphanumeric characters.

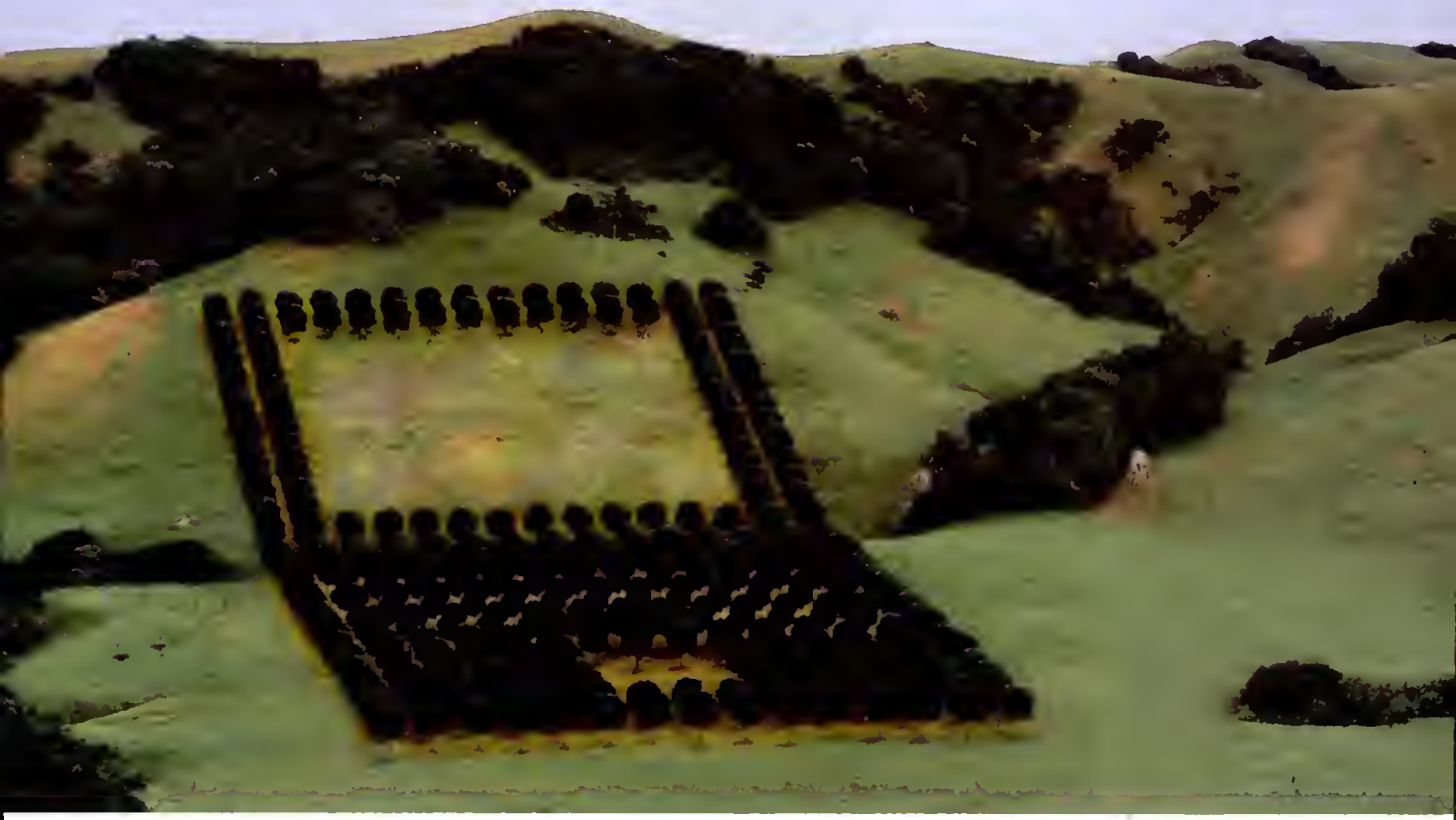
The Pilot also ships with a simple docking cradle that connects to your PC's serial port. Using the Pilot Desktop software or any popular PIM application (Organizer, Schedule+, or Starfish Software's Sidekick, among others), you can input data onto your PC and then automatically move it to your Pilot; a button on the docking cradle promptly synchronizes the data on each machine.

This simple yet powerful PDA is available in two different versions: The $249 Pilot 1000 stores up to 500 addresses, a year of appointments, 100 to-do items, and 50 memos, while the $299 Pilot 5000 handles roughly five times as much data. Each can run for several months on a pair of AA batteries. A 1MB memory upgrade (about 15,000 records) is an additional $99, while a modem cable is $19.95.

Apple Computer is advancing the PDA genre a step farther with its upcoming **MessagePad 2000,** a hand-held device that integrates a word processor, a spreadsheet, and Internet software as well as standard PIM applications. The MessagePad, roughly the size of a videocassette (1.1 by 4.7 by 8.3 inches) and weighing less than 1.5 pounds, is designed around Apple's Newton 2.1 operating system. You can input data simply by writing on the unit's display with a stylus; it recognizes both print and cursive characters. The unit also has four on-screen keyboards (typewriter, numeric, phone, and time/date); an optional external keyboard (90 percent of full size) is also available.

Apple's Newton Connection Utilities can transfer MessagePad data to and from a standard PC or Macintosh over a serial

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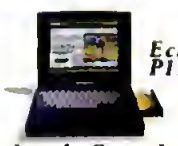
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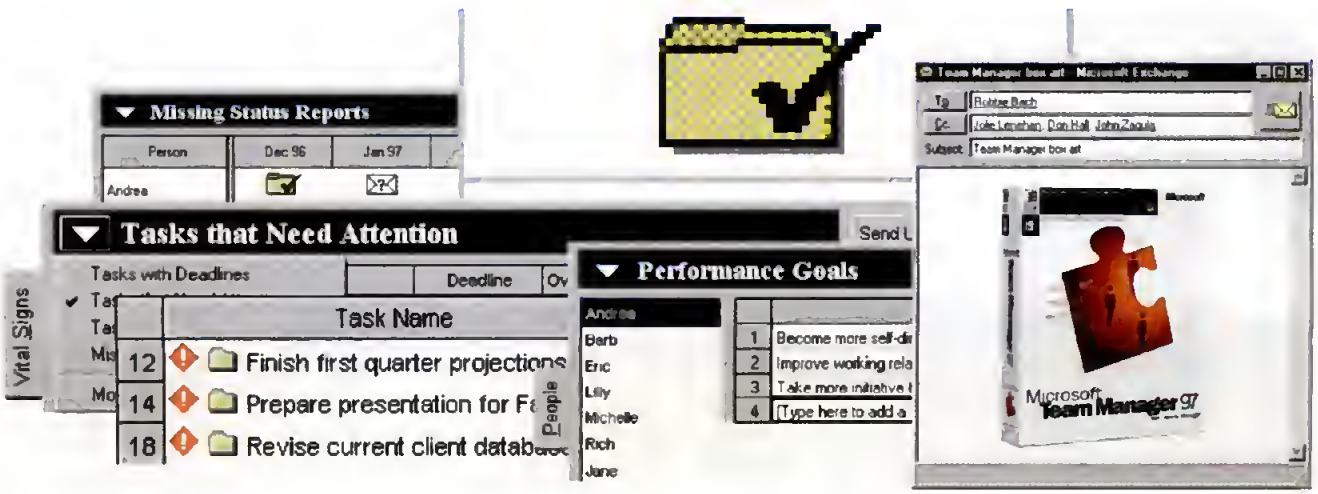
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cable; it supports most popular desktop PIM software, including Claris Organizer, Lotus Organizer, and Microsoft Schedule+. Newton 2.1 also supports low-level sound recording, enabling you to add voice notes to visual notes. With the built-in microphone and speaker, you can store and play back anything from personal reminders to entire conversations.

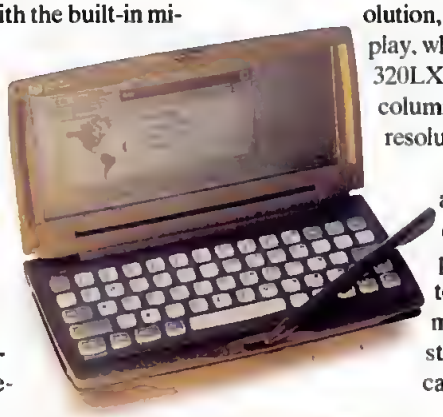
The unit's two PC Card slots support memory cartridges, additional applications, and a variety of modems. With the latter, you can send and receive faxes, use e-mail, and access the Internet via the MessagePad's integrated Web browser. A serial port, a parallel port, and an infrared interface collectively let you connect to a variety of PC- and Mac-based peripherals.

The MessagePad is backed by a 160-MHz StrongARM RISC processor, 8MB of ROM, 5MB of RAM, and a 480-by-320 backlit screen that supports 16 levels of gray and 100 dots per inch. This remarkable unit can last for three to six weeks on either AA alkaline or optional nickel hydride batteries, but it also runs on AC power. By the time you read this, Apple should be selling the MessagePad 2000 for just under $1,000.

The future of the PDA may lie with Microsoft's Windows CE, however. Once code-named Pegasus, this 32-bit, graphical operating system for palmtop systems was introduced in January and has already shipped with several new PDAs (First Looks, "Pocket Windows," *PC Magazine*, January 21, 1997, page 45). It offers the familiar Windows 95 interface and simplified versions of familiar Windows 95 applications, including Pocket Excel, Pocket Word, and Internet Explorer 2.0. Palmtops using the OS offer multitasking and an instant-on feature that eliminates the usual PC boot-up process.

This summer, Hewlett-Packard Co., a longtime palmtop market leader with its HP 200LX, will enter the Windows CE market. The **HP 300LX Palmtop PC**, equipped with 2MB of RAM, and the **HP 320LX Palmtop PC**, with 4MB, each have a Type II PC Card slot and a flash memory card slot.

The beauty of HP's design compared with existing Windows CE machines is its display. While current Windows CE devices offer 60 columns and 480-by-240 resolution, HP's gray-scale display, which is backlit on the 320LX, supports 80 columns and 640-by-240 resolution.



Tha HP 300LX Palmtop PC takas Windows CE a step further with its expandad display.

Two AA batteries are enough to deliver four weeks of power, while an integrated keyboard mirrors that of a standard PC. Because the display is touch-sensitive, no mouse or pointing device is required; a stylus inside the machine pops out easily when needed.

With the included docking cradle, you can synchronize your Windows CE applications with their Windows 95 and Windows NT desktop counterparts. The unit also offers an infrared transceiver, a serial port, an integrated speaker, and an AC adapter; it's expected to sell for about $500.

IBM'S HOME DIRECTOR

The culmination of PC-based domestic technology rests with IBM Consumer Division's seminal **Home Director** paradigm. First introduced in May of last year, Home Director is a hardware and software scheme that works in tandem with an IBM Aptiva PC to automate your electric lights and appliances.

IBM is now developing a voice-enabled version of Home Director that will turn on your coffee maker or light up your attic by mere suggestion. Essentially, this new system—Version 3.0—uses the same setup as the original product. A Home Director Serial Interface connects your PC serial port to a standard wall outlet. Via your existing electrical wiring, this device is then able to communicate with various modules around your home. Each module is plugged into an outlet, connected to an appliance or lighting fixture, and assigned a particular code. Using such codes, your PC can control the attached devices remotely.

When you launch the Home Director software on your PC, it loads an IBM VoiceType Connection Speechbar that either integrates with the Home Director software or floats freely in its own window. After you've given the simple verbal order "wake up," the Speechbar will respond to innumerable point-and-click or Home Director–specific commands. You can create graphical representations of each module, schedule events to occur at any time during the day, and program multiple-event routines. Version 3.0 also supports radio-frequency and infrared remote control and telephone operation.

The Home Director Starter Kit ships only with and works only with IBM Aptiva PCs ("Home PCs: High Style, High Speed," *PC Magazine*, December 17, 1996). The voice-activated Version 3.0 should be available by spring 1997.

Luddites, beware: Every aspect of your domestic life could soon be dependent on the PC. The home computer is no longer an abstruse machine with an insipid countenance. It's a colorful piece of art deco for the living room, a modern cookbook, a variation on the infamous idiot box, a personal secretary, and a Big Brother for the family abode. All we need now is a PC that does the dishes. □



With IBM's Aptiva PC and voice-controlled Homa Director, homa control is a mare suggestion away.

FUTURE MICROPROCESSORS

Cost, not technology, will be the greatest barrier to future chip developments.

By Laura Peters



In 15 years, microprocessors will be racing at gigahertz speeds, cashing in millions of transistors on a chip the size of your thumbnail. On it will be a mile or so of stacked wiring laid with molecular precision. The main challenge going forward will be to maximize the speed of the interconnect—a dilemma with which PC vendors also grapple today, since on-chip speeds are roughly five times as fast as chip-to-board speeds. Signal propagation delays across multiple metal layers will also be highly problematic for chip designers.

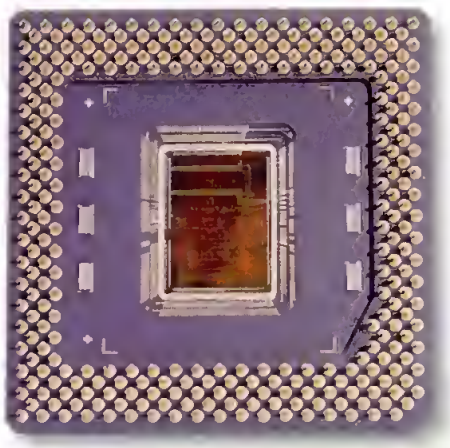
In the future, more powerful chips will enable an abundance of PC applications, limited only by our imaginations. Already, microprocessors allow such functions as handwriting recognition and language translation. Still, there are obstacles to advancing chips. If technologies aren't the barrier, then what is?

COST BARRIERS

One obstacle to advancing microprocessor technology is the cost of building a semiconductor-manufacturing facility (or *fab*), now over $1 billion. There are about 1,000 fabs today; the hundred or so that will be built before 2012 will be even more costly. Yet such costs are nothing compared with the price of bringing chips to market: Intel's first Pentium chip, for example, cost over $5 billion to develop. Developing the chips of 2012, be they of RISC or CISC architecture, may cost something like $10 billion.

In fact, Intel's Gordon Moore has identified the expense of chip making as a limiting factor. Moore should know, since he first noted, in 1965, the strategy of scaling down transistor size to create smaller, faster, more functional chips cost-effectively (in a trend known since as *Moore's Law*). Hence, faster, smaller computers come out every year.

Visionaries could argue that there is no real barrier to chip development and that



Next-century processors may use a billion transistors; today's MMX Pentium has but 4.5 million.

if we use technology properly, it will enable much more than improved productivity. Perhaps we can push the window open further to realize any number of advances. Can tomorrow's technology be embraced to allow for greater advances in areas such as education and cultural appreciation? Stranger things have happened—even in the electronics industry.

THE SILICON ARCHITECTS

Trying to speed processing by minimizing signal propagation delay, designers have effectively stacked metal lines of increasing length. Whereas chips in the late eighties used only one metal layer, today's state-of-the-art chips have four or five.

Though this stack will rapidly progress to eight or more layers, eventually the metal's capacity to handle the signal will reach its limit, and new methods will be necessary. The lines will likely consist of copper instead of aluminum, because it is a better electrical conductor. And instead of the isolating silicon-dioxide film to separate the lines, fluorinated oxides will be deposited or spun on the wafer.

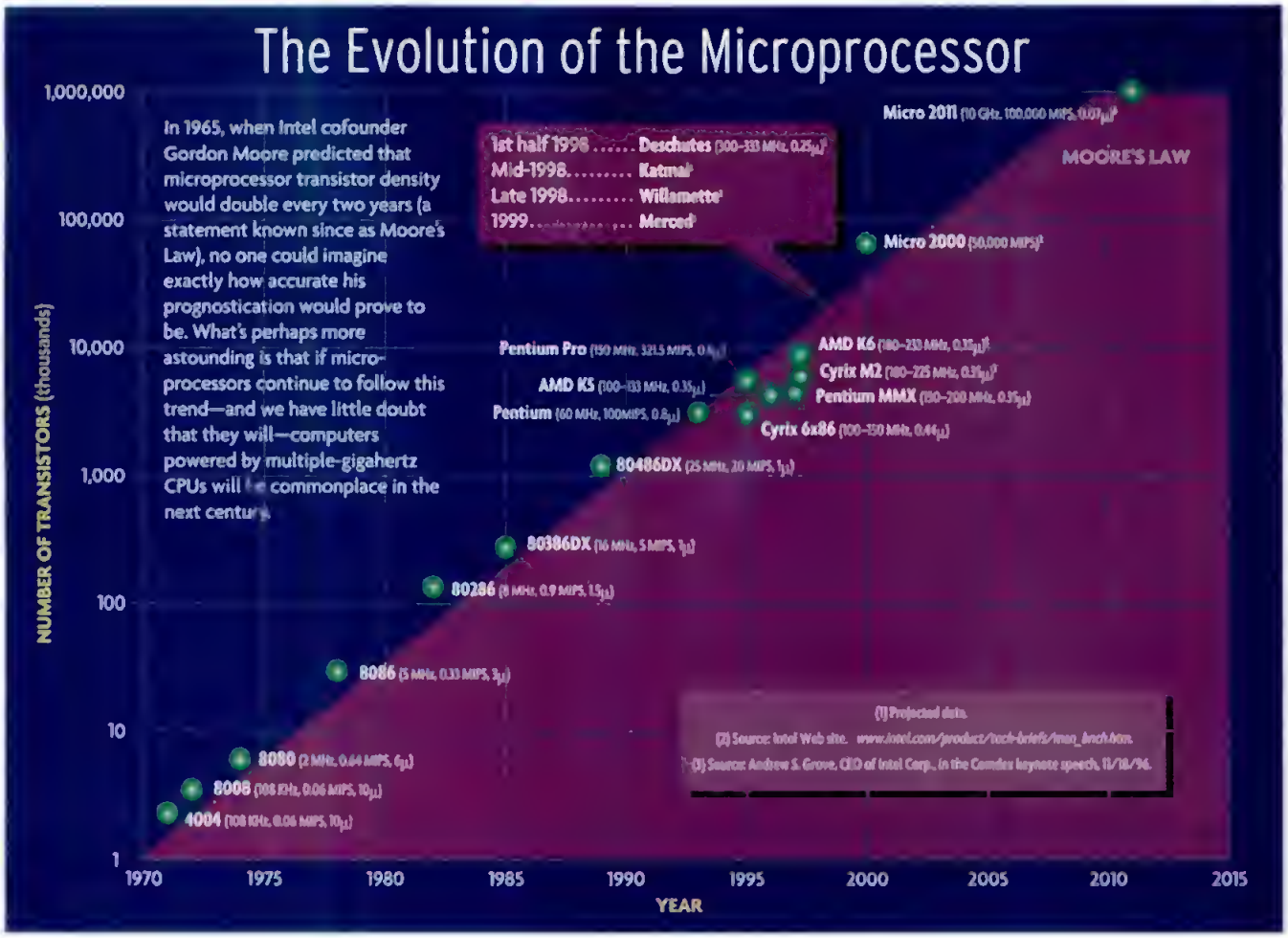
This magical combination of materials will reduce the wire's resistance/capacitance time constant. By minimizing the metal's resistance and lowering the isolating film's dielectric constant, chip designers will enable faster signals. Here is where the choice of technologies becomes crucial.

KEY ADVANCES IN PROCESS TECHNOLOGIES

In the semiconductor industry, cost concerns and technology go hand in hand. There are a handful of process technologies used to make chips today; wafer-processing steps monopolize the devices' overall cost. At the wafer level, processes currently used include lithography, ion implantation, diffusion and oxidation, deposition, etching, cleaning, planarization, and metrology.

Chip manufacturers begin the wafer process by purchasing the silicon wafers in sizes of 100, 125, 150, and 200 millimeters. Pizza-size wafers (300 mm, or 12 inches) are expected to enter production after 1998. Development of 400-mm (16-inch) wafers may also be under way, to a small extent.

Lithography drives this market: It is the imaging technique that precisely patterns each circuit element, and it also requires the fab's most expensive toolset. In this process, *optical wafer steppers* use precision optics to focus a light wavelength of 365 nanometers (soon to be 248 and even-



tually to be 193 nanometers) onto the wafer, which is coated with a light-sensitive film, *photoresist*. (The development of shorter wavelengths is heightening demands on manufacturers of steppers, quartz, and other materials.) Either *etching* or *ion implantation* comes next. Selective etching of the exposed films creates the trenches that will later be filled with metal. Ion implantation, a completely different process, lets engineers precisely modify the chip's electrical characteristics by accelerating charged atoms (ions) in an electrical field into the silicon surface.

Diffusion and *oxidation* take place in 12-foot vertical tube reactors holding hundreds of wafers. Technology is demanding a shift to fast-ramp furnaces, but the current method has essentially been mastered and is cost-effective.

Deposition of films also takes place in reactors but with one wafer at a time, a difference that slows down the fab process significantly. Without our enormous advances in computer technology and software, the fab would be a logistics nightmare; ironically, it depends on the very technology it enables.

Etching reactors are also single-wafer systems, selectively removing films of aluminum, tungsten, silicon, polysilicon, silicon dioxide, and photoresist, as well as a myriad of residues. Cleaning occurs hundreds of times per wafer; astoundingly, a typical fab uses an estimated 50 acre-feet of water daily, or an area the size of 15 football fields with a depth of 1 foot. This issue is usually a logistics challenge, and it can be an economic hardship in countries without access to cheap water. This process also uses enormous amounts of electricity.

INSIDE

AMD'S K6
CYRIX'S M2
INTEL'S KLAMATH AND BEYOND
WHAT ABOUT RISC?

Manufacturers can accomplish *planarization* (the production of flat films) using a wet chemical and a mechanical polishing tool modified from prime silicon polishers. This method is only now nearing widespread acceptance in the semiconductor industry, because of issues of film uniformity, equipment reliability, and competing technologies.

Finally, there is *metrology*. Simply put: If you can't measure a 0.1-micron line, you don't know whether you have a 0.1-micron line. Metrology checkpoints in the fab line go a long way toward ensuring precision. But with these tools' costs rivaling those of the wafer steppers, you might prefer a smart system to a technician peering into a fancy microscope.

CONCLUSIONS

Current technologies' limits and the laws of physics will not prevent the world's best engineers from creating astounding chips 15 years from now. The cost issue is mind-boggling, but it may not be a real barrier. When we see 2012's microprocessors, with their hundreds of millions of transistors, a new age will be upon us. We won't call it "the digital age" or "the information age," as both will be dead terms. But regardless of the language or the time, we'll still be asking, "What are the barriers?"

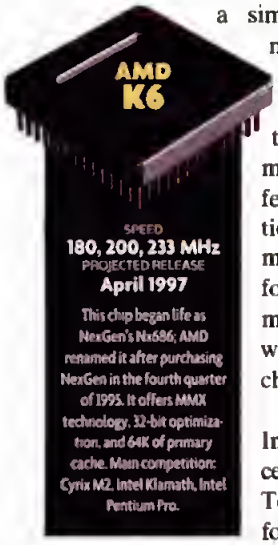
EMERGING MICROPROCESSORS

RENEWED COMPETITION

AMD and Cyrix are muscling their way into the market as Intel rushes to push the technology into the next generation. **By Cade Metz**

When charting the near future of the microprocessor, second-sourcing and North American geography are as relevant as cache size and clock speed. The perennial also-rans of the microprocessor market, AMD and Cyrix, are on the verge of competing with Intel's premium chip designs, while Intel is hoping to further its market dominance with a series of processors code-named for (of all things) Pacific-coast rivers.

Such an esoteric naming convention is indicative of chip evolution on the whole. For years, Intel used a simple, incremental method to name its CPUs (286, 386, 486, P5, P6, and so on), which it introduced into a simple, incremental market. Today, the market has neither characteristic. Not only are manufacturers offering new instruction sets and new motherboards, but for the first time, the market's high end will include three chip vendors.



At the moment, Intel's Pentium Processor with MMX Technology is the foremost option in the home markets, while the Pentium Pro dominates the high end of the *x*86 space. Both have shortcomings, however. The MMX Pentium uses Intel's MMX technology (a set of 57 new instructions for enriching PC multimedia), but it is not optimized for a 32-bit OS such as Windows NT. The Pentium Pro offers 32-bit optimization but lacks MMX. The best of both worlds is imminent—from Intel and its competitors.

AMD COMES OF AGE

AMD hopes to contest Intel's high-end dominance with the *K6*, an MMX CPU that will likely debut in mid-April at speeds as high as 233 MHz. When AMD unveiled a 200-MHz K6 prototype at Fall Comdex, the chip outperformed a comparable Pentium Pro under Windows NT and signaled a resurgence for the struggling AMD.

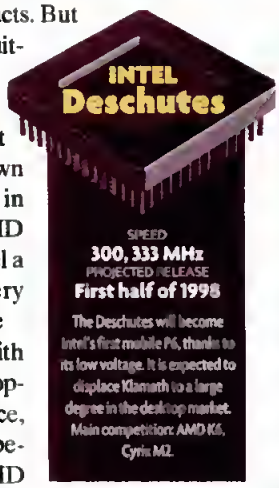


Since its 8088 clone debuted over 15 years ago, AMD has consistently delivered less expensive chips than Intel's mainstream offerings. AMD conceived its Pentium competitor, the *K5*, as a high-end chip, but a cache defect set the K5 back several months and resulted in significant financial losses. The K6 now fills the role of AMD's silicon savior.

The K6 began its life as the Nx686, but AMD rechristened it after purchasing it and its parent company, NexGen, last winter. (AMD did have its own sixth-generation chip in the works, but the company scrapped that design in favor of NexGen's.) Manufactured on a 0.35µ process, the K6 is a 16-mm² device that plugs into a Pentium socket. Different versions will run at clock speeds of 180, 200, and 233 MHz.

Later this year, a die shrink to 0.25µ should produce a 300-MHz incarnation. The chip also features 32-bit optimization, an implementation of MMX technology, and 64K of L1 cache (which minimizes time-intensive calls to the L2 cache or main memory).

Whereas past AMD chips were merely clones of Intel designs, in-house engineers built the K5 and the K6 from scratch. The company can use the original *x*86 instruction set free of charge under a patent cross-licensing agreement. With MMX, the agreement give AMD the right to see and use Intel's MMX technology to develop compatible products. But because K6's circuitry is different from the Pentium's, AMD must implement its own version of MMX in its CPUs. AMD must also pay Intel a royalty for every MMX-compatible processor sold. With MMX and 32-bit optimization in place, the K6 should become the first AMD product to challenge high-end Intel chips.



CYRIX: THE NEXT GENERATION

Cyrix has similar expectations for its *M2* chip, which it will also introduce in the second quarter of this year. About a year ago, the company introduced its first 6x86 design—a 133-MHz chip that outperformed the Pentium/166. A 150-MHz version subsequently reached the Pentium/200 level and proved a legitimate high-end option for Windows 95 users. Yet the 6x86's success in the lab did not translate to success in the marketplace. Though Cyrix won the industry press's support and even established its own line of PCs to promote the 6x86 name, it sold relatively few chips.

With the M2, Cyrix hopes to compete with the MMX Pentium. Like the K6, this 6x86 derivative has a Pentium pinout, an MMX instruction set, and 64K of L1 cache. It's manufactured on a 0.35µ process and is, at roughly 200 mm², slightly larger than the current Pentium Pro die (196 mm²). (The cost to manufacture a chip is related to its area: Larger chips mean fewer chips per wafer.)



At its debut, the M2 will be available in 180- and 200-MHz versions, and it should soon graduate to 225 MHz. That version will use a 75-MHz bus, which will give it an obvious bandwidth advantage over the MMX Pentium. Like the MMX Pentium



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(but not the K6), the M2 has a split-voltage design: It interfaces with external components at 3.3 volts, but its inner core runs at 2.8 volts. Once the inner core is reduced to 2.5 volts sometime in the second half of the year, the M2 may debut in mobile PCs.

Rather than licensing MMX from Intel, Cyrix has equipped the M2 with its own version of the instruction set. Because of past court decisions, the company is allowed to clone the MMX technology from public documentation and even plans to use its three-letter tag.

LIKE A RIVER TO THE SEA

Beginning with *Klamath*—a smaller, less complex MMX version of the Pentium Pro—each upcoming Intel CPU is codenamed after a Pacific Northwest river. Note that because Intel will not comment on unannounced chips, much of the discussion herein is based on published reports from the industry's leading newsletter, *Microprocessor Report*.



The Klamath chip will reportedly debut at 233 MHz before midyear, graduating to 266 MHz soon thereafter. It will probably have a larger die size than the extant Pentium Pro but use a 0.35µ CMOS process, which delivers lower power consumption by eliminating the bipolar transistors used in BiCMOS processes.

Whereas the Pentium Pro uses an integrated L2 cache (one dual-cavity package contains both the CPU and the L2 cache), Klamath is reportedly a single-chip device that uses an off-board L2 cache à la today's Pentiums. This approach lowers production costs but also reduces efficiency. The Pentium Pro's L2 cache runs at the CPU's clock speed, but Klamath's L2 cache will probably run at half the CPU clock speed. That's still faster than the Pentium (which talks to its L2 cache at a system-bus speed of either 60 or 66 MHz, depending on the CPU's speed).

To offset performance losses, Intel has reportedly upped Klamath's L1 cache.

What About RISC?

By Cade Metz

As AMD and Cyrix contest Intel's *x86* dominance, Intel is readying a challenge to the major RISC vendors. This is not a new fight; only two years ago, the microprocessor behemoth was put to the test by the PowerPC, a RISC processor developed by Apple, IBM, and Motorola. Needless to say, Intel won that battle (at least in terms of market share).

Whereas the Pentium, the Pentium Pro, and their mainstream competitors are CISC (complex instruction-set computing) processors, workstation-class CPUs such as the MIPS R10000 and Sun's UltraSPARC use RISC (reduced instruction-set computing) designs. RISC chips use simpler instruction sets to achieve higher clock frequencies and process more instructions per clock cycle than CISC processors.

Historically, RISC designs have also delivered much better floating-point performance than their CISC counterparts. Even Intel's flagship Pentium Pro doesn't match the floating-point performance of most RISC-based CPUs. Floating-point performance is crucial for workstation users running CAD, imaging, and 3-D modeling applications, a market Intel wants to breach with Pentium Pro machines.

Today's RISC-based systems are the leading option for professionals who depend on calculation-intensive tasks. Systems with multiple Pentium Pro chips are beginning to reach a similar market, however, because of their attractive price/performance ratio relative to RISC machines. Yet the true long-term threat to the RISC platform may be the upcoming IA-64 instruction set—the result of a partnership between Intel and Hewlett-Packard.

RISC AT RISK

The chief caveat as to RISC chips is that they don't afford the widespread compatibility that an Intel chip does. Whereas the *x86* instruction set has become a de facto industry standard, RISC chips are relatively esoteric products with relatively little software support. IA-64 is a fresh 64-bit instruction set coupling RISC-like performance with Intel's far-reaching influence. Though Intel and HP jointly developed IA-64, it's Intel that will actually produce the chip. Originally called the P7, this chip was renamed Merced.

When Merced debuts (reportedly by the end of the century), it could render RISC chips obsolete. Not only will its 64-bit design run *x86* software and emulate HP's PA-RISC code, but it will probably perform better than most RISC offerings as well.

As Merced comes into play, other RISC vendors may develop new instruction sets similar to IA-64 or merely adopt IA-64 itself. Today, however, companies such as Digital, HP, IBM, MIPS, and Sun are advancing their RISC models.

When it debuts toward the end of this year, Digital's Alpha 21264 microprocessor should offer the highest performance on the market. This CPU will likely debut at a clock speed of 500 MHz; it reportedly has two 64K L1 caches and employs a 64-bit system bus that approaches 333 MHz. At a reported 300 mm², it is larger than the average *x86* chip die and has over 15 million transistors—almost three times as many as a Pentium Pro.

Another performance leader in the RISC space is Hewlett-Packard's PA-8200. Already shipping to HP partners and planned for volume shipments in mid-1997, this 64-bit chip measures 337.69 mm² and will have an initial clock speed of 220 MHz. Unlike other high-speed chips, which are increasingly relying on larger L1 caches, the PA-8000 series use large L2 caches. The PA-8200 will use two 2MB L2 caches; the CPU will have roughly 3.8 million transistors. HP will use a 0.5-micron CMOS manufacturing process for the PA-8200, but it should graduate to a 0.25-micron technology with the PA-8500 (due in 1997).

PERFORMANCE LEADERS

By the time the PA-8200 arrives, new 0.25-micron incarnations of the MIPS R10000 and Sun's UltraSPARC-2 should be shipping. These will run at 275 and 250 MHz, respectively, but they probably won't match the performance of HP's chip. This year, IBM will begin shipping its 266-MHz PowerPC 620, which will (like the new R10000 and the UltraSPARC-2) rival the current performance leader, Digital's 500-MHz Alpha 21164.

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Intel confirms that the CPU will also be on a card surrounded by plastic and metal casing and attached to the motherboard via an edge connector. This SEC (single-edge contact) cartridge is designed to reduce electrical emissions that may affect high-speed CPUs.

Today's Pentium Pro motherboards will be able to accept Intel's forthcoming SEC cartridges with the addition of a connector. With processor cards adopting new chip designs, new caches, and new cache interfaces, third-party motherboards will require relatively few changes. The SEC cartridge actually gives Intel greater control over PC configurations (although the company will initially purchase its SRAM caches from other sources) and could keep other chip vendors from adopting the Pentium Pro platform; the P6 bus is still legally protected by Intel.

Klamath will probably be more adept than its predecessor at running 16-bit code. Under 32-bit code, it should match the current Pentium Pro's performance, albeit at higher clock frequencies.



INTEL: GEOGRAPHY AND HEGEMONY

Intel's subsequent offering will be the *Deschutes* chip (named for a river that runs through Oregon). Reportedly manufactured with the 0.25µ CMOS process, this low-voltage Klamath descendant will likely measure 120 mm^2 and debut at 300 to 333 MHz. It is scheduled for introduction in early 1998, and by the end of that year it should become Intel's first mobile Pentium Pro offering. Until then, 166- and possibly 200-MHz MMX Pentiums will command the high-end notebook market.

With *Katmai,* Intel has turned to Alaska for a river name. Set to debut in the middle of 1998, this Deschutes revision should offer an addendum to MMX, known appropriately as MMX 2, which may include more 32-bit instructions than today's largely 16-bit MMX instructions.

Originally known as the *P68,* Intel's late-1998 offering is named for yet another Oregon river. *Willamette* will reportedly use an enhanced Pentium Pro core that may outperform Klamath and Deschutes by close to 50 percent. Its die will probably be substantially larger than Klamath's and Deschutes's, but it could come to market with a 100-MHz bus.

Willamette will presumably anchor mainstream desktops in 1999 and 2000 as the celebrated *Merced* processor eases into the market. Named for a California river, Merced marks the end of the *x*86 architecture and the debut of *IA-64.* This 64-bit instruction set is the result of Tahoe, an Intel/Hewlett-Packard partnership named not for a river but a lake. Though the two companies jointly defined the architecture and its software interfaces, the physical chip is solely an Intel venture.

CPU choices will abound by midyear, as will confusion caused by different clock speeds, instruction sets, and motherboards.

Merced should ship in 1999, but it will not enter the mainstream before the turn of the decade. The Merced core, reminiscent of workstation RISC chip designs (see the sidebar "What About RISC?"), will reportedly run *x*86 code without software assistance. Until Microsoft ships a 64-bit operating system early in the next decade, only Unix users will realize Merced's full potential.

THE PEOPLE'S CHOICES

By the middle of this year, the CPU market will be at its most perplexing. Intel will offer the MMX Pentium, the Pentium Pro, and the first Klamath, which its principal rivals will challenge with the M2 and the K6. That's two pinouts, three motherboards, five clock speeds, and two instruction sets.

In the corporate market, the Pentium Pro—lacking MMX and dependent on obsolete motherboards—will begin to fade by the end of the year. Businesses will then have a choice between Klamath, the K6, and the M2, all of which include both MMX and 32-bit optimization.



Even if the K6 and the M2 meet expectations and rival Intel performance under both Windows 95 and Windows NT, they will have difficulty making inroads. Before committing to them, PC vendors must overcome a twofold reluctance: Will Intel punish those who use competing chips, and is the Pentium pinout on the verge of obsolescence? AMD and Cyrix have proven they can deliver premium chips; now they must prove they can market them.

AMD hopes that five of the top ten PC manufacturers will use the K6 by midyear. That is conceivable, considering that the chip will sell for about 25 percent less than Intel's highest performer, whether Klamath or the Pentium Pro. AMD has learned from the fate of the Cyrix 6x86, originally priced on a par with the Pentium and a rather poor seller.

Meanwhile, Cyrix is planning to position the M2 against the MMX Pentium. Such a strategy may lessen the chip's role in the corporate sector, but it could lead to success in the home desktop and notebook markets. The M2's primary advantage over the K6 and Klamath is its split-voltage design, which could give it a mobile presence months before the debut of Deschutes.

Cyrix may be hampered by the fact that it's a fabless company, however. Reports have circulated that the vendor has had trouble getting enough 6x86 parts from its current fab partners, IBM Microelectronics and SGS-Thomson (a rumor that Cyrix denies). This potential problem will not affect AMD, as it currently owns two state-of-the-art fabrication facilities.

If the K6 and the M2 do indeed crack the fraternity of elite PC vendors, the distant K7 and the M3—which will presumably abandon the Pentium pinout—won't have to endure the stigma that non-Intel chips now face. Yet there are many rivers they will have to cross. □

FUTURE DISPLAY TECHNOLOGY

Breakthroughs in plasma, CRTs, and LCDs will widen and brighten our views.

By Alfred Poor



From the day that the first IBM PC arrived, we have peered at our data on a vacuum-tube screen. While we readily assume that our futures will be filled with inexpensive wall-size flat displays in our offices and homes, we're still a long way from affordable access to that kind of technology.

But if the road from here to there is long, it already is defined clearly in the technologies we'll be relying on for displays in the next decade and beyond. Thanks to the success of portable computers, flat-panel display technology has advanced by leaps and bounds. Not to be left behind, the familiar vacuum-tube display is changing with the times. There are also exciting and exotic technologies beginning to emerge from laboratories around the world. It is still hard to know which technologies will be winners in the end, but you certainly can count on the future being lighter, brighter, thinner, and more affordable.

INSIDE

WIDE SONY CRTs
20-INCH NEC AND SCEPTRE LCD MONITORS
PIXELINK PLASMA PANEL

CRT: STILL A LONG SHELF LIFE

The familiar CRT, or cathode ray tube, has been around in one form or another for nearly 100 years. In a CRT, a stream of electrons is beamed from one end of a vacuum tube to the other, where a layer of chemical phosphors glows with different colors in response to the electrons. The standard desktop monitor and tbe home television share the same fundamental design principles, though they are implemented quite differently.

Home television designs favor image brightness and compact size, while computer screens need to be engineered for higher resolution and sharp images. It is difficult to make the image on a monitor as bright as television, because the extra power required to drive the electron beam harder causes the *shadow mask*—a perforated metal mask that defines the pixels we see on-screen—to heat and deform, which hurts resolution and image quality.

There have been many changes in recent years that improved CRT monitor quality. New materials such as Invar for shadow masks have more thermal stability to resist the effects of electron beam heat. Screen technologies such as aperture grilles, black matrix masks, and Toshiba's Microfilter increase contrast and color purity, and advances in antiglare coatings have improved image quality. NEC's new CromaClear slot mask also has made CRT images noticeably sharper and brighter.

We have not yet seen everything under the CRT sun, however. The FCC finally has approved a plan that will let implementation of HDTV—high-definition television—proceed. This could create a convergence between the television and data monitor markets, as HDTV specifications call for resolutions of up to 1,920 by 1,080 pixels, which is more than adequate for desktop data displays. Not only does this work well with digitized video (especially DVD multimedia), computer users also may appreciate the wider workspace offered by a 16:9 ratio screen (compared with the now-standard 4:3 proportions). As a result, desktop monitors may enjoy economies of scale if the consumer television market also embraces HDTV and both types of designs can use the same tubes. In the interim, some makers are testing the waters with wide-aspect-ratio displays. Sharp introduced its WideNote notebook computer with a wide, rectangular screen, and we review Sony's GDM-W900 wide-aspect desktop monitor later in this section.

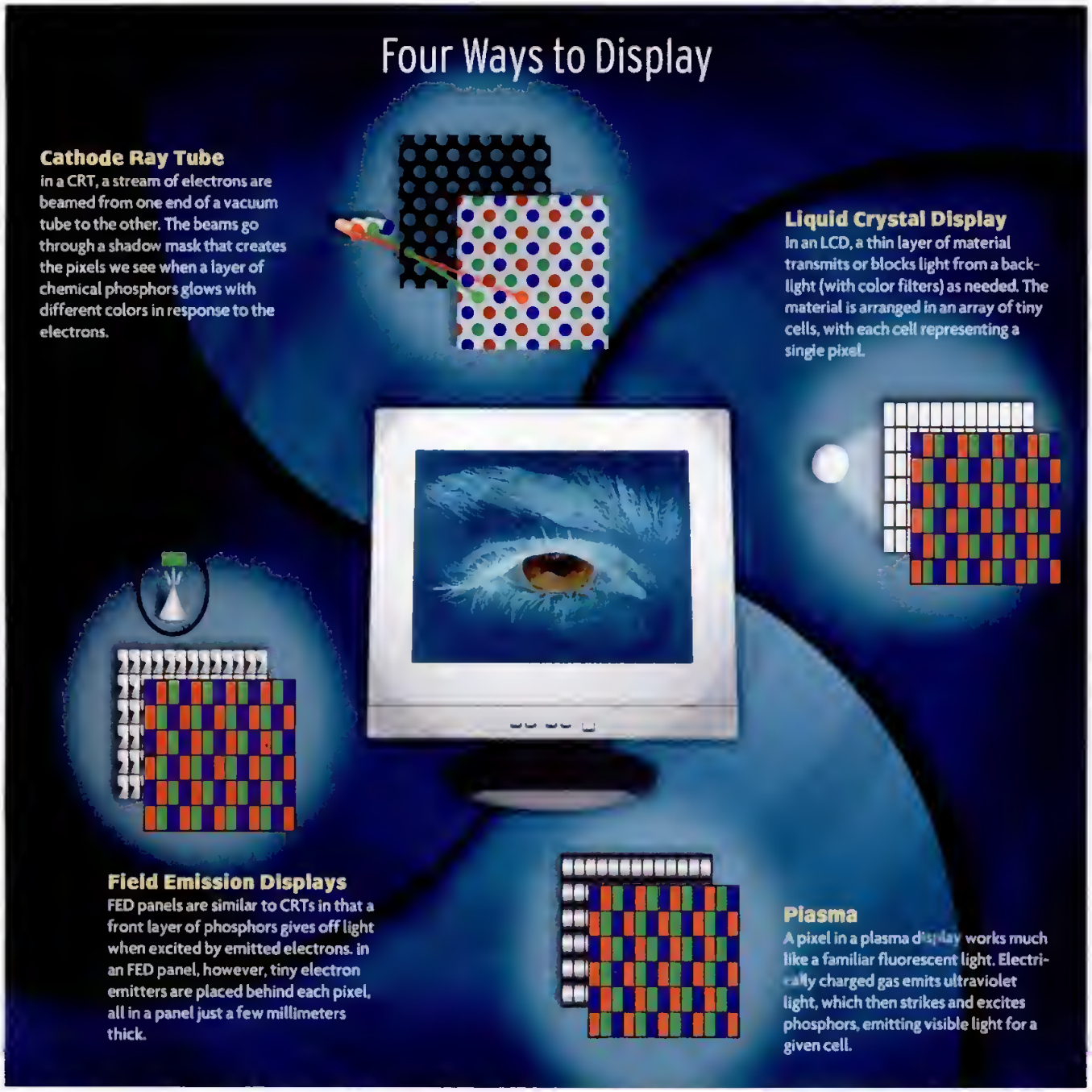
Two problems remain with standard CRT designs: As the screen size gets bigger, the depth and weight of the unit increase dramatically. Right now, a monitor is about 1 inch deep for every inch of diagonal screen real estate. So even 20-inch displays are not practical for many users, because there simply isn't enough room on the desk. In the labs, there are radical designs that place the electron guns along one side of the screen, resulting in a greatly reduced tube depth, which in turn could mean lighter and smaller CRTs for a given screen size.

LCD: THE NEXT DESKTOP STANDARD?

While CRTs enjoy an enormous lead in the marketplace, the manufacturers surely are hearing the footsteps of other technologies that are closing ground. The most visible and active challengers are LCDs—liquid crystal displays.

Made popular as notebook displays, LCDs are conceptually simple: A thin layer of material can be used to transmit or block light. With this material arranged in an array of tiny cells, each pixel in an image can be turned on or off as required.

LCDs have significant advantages over CRTs for the portable market. They are lightweight and thin, and their power consumption is low enough that they can be run from batteries. As tbey move to the desktop, however, only the thin attribute



provides a compelling advantage. Notebook users will pay a premium for portability and put up with a small display, but desktop users are loath to pay more for less than they can get with a CRT.

A number of important changes have occurred in the LCD market that may alter this situation. First and foremost, LCD manufacturers have found ways to increase the yields of production lines, helping to drive down display costs. According to some sources, the yield on 10.4-inch active-matrix LCD panels is still as low as 60 to 70 percent, and production improvements make it possible for yields of 80 to 85 percent to be achievable.

Another change to note is that LCD production lines have been designed to produce larger and larger sheets of glass, making it possible to make more panels at a time, or fewer larger panels. We now have seen the first 20-inch production units. Displays such as NEC's MultiSync LCD2000 reviewed here are far too big for notebook applications, and are clearly destined for the desktop.

There may be no limit to the size of LCDs. Sharp has demonstrated a 40-inch-diagonal active-matrix screen with a resolution of 800 by 600 pixels. The Sharp 40-inch TFT LCD is made by joining two 29-inch panels using a new bonding technique. The company has made only a technology prototype, however, and has no immediate plans to market a product based on this process.

People are used to both a bright image and a wide viewing angle from a desktop CRT, and advances in LCD technology

are attempting to achieve similar performance. New films have been designed to concentrate the light behind an LCD and diffuse it as it leaves the display. A number of different approaches have been taken to increase viewing angles, including the use of thinner LCD layers, high-tech optical films, and horizontal (or in-plane) switching, in which the LCD cells are arranged sideways in the panel.

The biggest problem with LCDs remains cost. An LCD for a desktop system still costs four to eight times as much as an equivalent monitor based on CRT technology. The problem gets worse as the screen size increases, because production yields drop as the size of the panel and number of pixels increase. It is possible that the prices will drop enough in the near future to make LCDs a competitive replacement for CRTs, but that remains years in the future. For the near term, it appears that an LCD plays best at sizes up to 20 inches diagonal. Beyond that, other technologies look more promising.

PLASMA: A PERSONAL THEATER

For really large flat-panel displays, a different technology has come to the fore. Fujitsu, Matsushita (the parent company of Panasonic), Mitsubishi, NEC, and Pioneer have all demonstrated 40-inch or larger color plasma panels, with some models ready to enter into production.

Plasma panels have been around nearly as long as the PC. The earliest were monochrome, with a rusty-red color to the pixels. They were used in transportable computers and as large, high-resolution displays for engineering workstations. Only in recent years were phosphors developed for full-color displays, along with new fabrication techniques required to accommodate the red, green, and blue phosphors.

A pixel in a plasma display works much like a familiar fluorescent light: Electrically charged gas emits ultraviolet light, which then strikes and excites phosphors emitting visible light. In some designs, the phosphors are at the front surface of the cell, while others have the phosphors at the back, and the front surface is transparent.

Here again, price is a limiting factor for the near term: Pixelink's 42-inch plasma display (which we reviewed) employs a Fujitsu panel and costs about $15,000. Over time, the phosphors degrade and the screen will lose brightness. Current panels are rated for 10,000 hours of use (or five years of 40-hour work weeks), which translates into more than $1 per hour.

Hence, most plasma screen manufacturers are targeting the market for 40- to 60-inch displays for corporate boardrooms and public displays, where their thinness (about 5 inches deep) and wide viewing angle make them attractive despite the high cost. In the future, lower prices and longer phosphor life could make such displays suitable for home theater.

The crystal ball for the future of displays shows sharper, brighter, thinner, and larger monitors for our PCs.

There are all sorts of other technologies just reaching the market, and depending on how development progresses, any one of them could become a major factor in the next generation of desktop displays.

For example, a number of companies have created micropanel displays. Instead of using glass or plastic as a substrate, these designs create a display device right on a semiconductor wafer employing more or less standard fabrication processes that currently are used for memory chips and other computer components. Many of these designs use liquid crystal technology, but some are based on more exotic approaches such as ferro-electric liquid crystals or defraction technology. Texas Instruments has also created its Digital Light Processing technology, which uses microscopic mirrors on a chip to deflect light. (We awarded DLP technology, which is currently being used in data projectors, an Award for Technical Excellence in 1996.)

These micropanel designs have been used for head-mounted displays and image projectors, and they could also be utilized as the basis for small desktop rear-projection displays to replace CRTs. At least one company—Fujitsu—has discussed plans to create such a device before the end of 1997, targeted to be about 5 inches deep and to sell for about 1.5 to 2 times the price of an equivalent-size CRT monitor.

FED PANELS: FURTHER IN THE FUTURE

CRTs and plasma panels are emissive designs—meaning that they emit light—in contrast to the transmissive approach of many LCDs or the reflective design of TI's DLP technology. There are a number of other emissive designs under development, including electroluminescent technology. One of the most promising new approaches in this area, however, is FED panels: field emission displays.

FED panels are similar to CRTs in that a front layer of phosphors gives off light when excited by emitted electrons. The difference is that instead of the three electron guns in a CRT, FED panels place dozens or hundreds of tiny electron emitters behind each pixel, all in a panel just a few millimeters thick. The effect is a digital panel in which each pixel is controlled directly—as with an active-matrix LCD—but where the light is emitted by the phosphors at that individual pixel as in a CRT.

There are a number of companies working on this technology, and PixTech has already produced a quarter-VGA monochrome panel in sampling quantities for developers. The company has also demonstrated full-color 6-inch and 10.5-inch FED panels. PixTech has formed alliances with Futaba, Motorola, and Raytheon, which have licensed the company's designs.

Another company that is making progress in the FED race is Candescent Technologies Corp., which calls its design Thin CRTs. The company's partners include Compaq and Hewlett-Packard. Candescent has announced plans to create a 12.1-inch color FED panel for use in an HP OmniBook portable in 1998, in which a CRT-like display could provide a competitive advantage over LCD designs.

While the crystal ball for the future of displays may be a bit out of focus at this point, it is clear that we can expect to see sharper, brighter, clearer, and larger monitors for our computers. And though we may have to pay more in the short term, many of these new designs will come in smaller and lighter packages.

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EMERGING DISPLAY TECHNOLOGY

WHEN COST IS NO OBJECT

The big, beautiful displays of tomorrow now are reaching the market, but their high prices will give most users pause. **By Alfred Poor**

From CRTs to LCDs to plasma displays, the cutting-edge crop of computer monitors is something to behold. Here we review the new wide-aspect CRT display from Sony, desktop LCD monitors from NEC and Sceptre, and a 42-inch Pixelink plasma display that can hang on the wall of the boardroom (or bedroom).

SONY'S WIDE WORLD VIEW

Take one look at Sony Electronics' **MultiScan GDM-W900** ($4,999) and you know you're looking at something different. Where all computer monitors have the nearly square 4:3 proportions, this new monitor has a 16:10 wide view similar to HDTV's 16:9 aspect ratio. The MultiScan W900 is big: Its CRT measures 24 inches diagonally and delivers a viewable area of 22.5 inches. Sony has targeted the new monitor for engineering, graphic arts, and video development applications.

As you might expect, not all graphics adapters are able to take advantage of the 30 percent extra width of the display area. At the time we tested the monitor, cards from Elsa, Integrated Micro Solutions, and Number 9 were available that supported the wide aspect ratio of the display (Sony provided the card from Integrated Micro Solutions for our tests). The unit has both standard and BNC coaxial connectors on the back, and a switch on the front panel makes it easy to toggle between input sources.

The monitor is capable of resolutions up to 1,920 by 1,200 pixels at a 76-Hz refresh rate, which is about the same resolution as a 1,600-by-1,200 image on a monitor with standard proportions. Its picture tube is based on Sony's famous Trinitron technology, so it has the familiar vertically flat front glass. The monitor uses a variable-pitch aperture grill (0.25 to 0.28 mm), which makes it possible to use a wider deflection on the electron gun yoke, so the tube can be made with less depth than in a traditional design. The monitor is about 21.5 inches deep, or about the same as a standard 21-inch monitor.

The large display area lets you see two desktop publishing pages side by side at full size. Not only is the display large but it also makes beautiful images. The only flaws noticeable on the screen were some slight convergence errors at the edges, but the monitor's on-screen menu included sophisticated screen-geometry adjustments, so it was quick and easy to make the image nearly perfect.



Sony's wide-view 24-inch CRT ($4,999).

NEC'S BOLD AND BEAUTIFUL LCD

If you like the idea of a flat-screen desktop monitor, but you need a large screen, you'll want to look at NEC Technologies' **MultiSync LCD2000,** which has a screen measuring 20 inches from corner to corner. We were able to obtain a prototype of the new display for evaluation, and in spite of some preproduction flaws, the monitor instantly drew crowds whenever it was in use. Alas, its high initial price—probably around $10,000—will keep it in the realm of specialty markets such as medical and financial institutions.

The active-matrix LCD panel has a resolution of 1,280 by 1,024 pixels. Setup for the monitor is easy: It uses an analog interface, so you can attach it to *any* graphics card capable of producing a 1,280-by-1,024-resolution image with a vertical refresh rate of 60 to 75 Hz. The monitor has a single set of multipurpose buttons on the control panel, with an on-screen menu system to let you configure the display quickly and easily.

Image quality is, in a word, breathtaking. In testing, colors were rich and saturated, and the high resolution made even small text crisp and easy to read. The image appeared to be as bright as on a CRT under normal office lighting conditions. Perhaps even more impressive, NEC employs *in-plane switching*: The LCD cells are arranged sideways, so the LCD crystals are arranged horizontally instead of vertically. This results in a wider viewing angle comparable to what you'd see on a CRT monitor. Indeed, we were able to move far off-center and still see the image clearly, which has been a sticking point for LCDs in the past.



NEC's 20-inch MultiSync LCD 2000 (about $10,000).

As you would expect from a display named MultiSync, the LCD2000 can display images at several resolutions. NEC's FullScan feature expands images displayed at less than 1,280-by-1,024 to fill the whole screen. This works well for VGA (640-by-480) images. Text-intensive SVGA (800-by-600) and XGA (1,024-by-768) images, however, can be difficult to read, as the stroke weights within individual letters vary greatly.

SCEPTRE'S PORTABLE UNIT

While NEC's 20-inch LCD may prove too exotic and pricey for most users, other LCD manufacturers are rolling out somewhat more accessible models. The **Sceptre CD-1215T,** from Sceptre Technologies ($3,695), is a 14.5-inch active-matrix LCD with 1,024-by-768 resolution aimed at mobile professionals and vertical markets such as hospitals and industrial clean rooms.

The unit's screen may not sound particularly large, but keep in mind that the true 14.5-inch viewable area is an inch or more larger than what you get on a 15-inch CRT. You cannot use a standard graphics adapter, but the list price includes a proprietary graphics adapter based on the Trident 9662 chip set. This card provides a digital interface for the monitor, and a single cable with high-density connectors carries both power and the image signal from your computer to the display.

Unlike a CRT, which can produce a nearly infinite range of colors, the LCD panel used in the Sceptre display is limited to 262,000 different colors. Also, the graphics card driver is limited to 256 colors. These limitations might pose a problem for graphic artists, but the color images on our tests looked good for general-purpose applications.

One attractive feature of the display system is that it gives you a choice when displaying images of a lower resolution (such as 800-by-600 or 640-by-480). You can choose to have the image shrink on the screen so that it uses one LCD cell per pixel, or you can have the display expand the image to fill the screen (although this approach can make small type difficult to read, as some strokes in the letters will be thicker than others).

Another handy aspect of the design is that you can remove the panel from its base and hang the display on a wall. The unit is only 2.5 inches deep, and it weighs 7.5 pounds without its base, which makes it valuable as a portable presentation aid. The display also has built-in stereo speakers.

The CD-1215T costs about four times as much as an equivalent 17-inch monitor does, so you pay a significant premium for saving space and weight. The product's proprietary interface is a limitation, but Sceptre plans to have an analog version of the monitor out soon that will operate with any standard graphics adapter.



Sceptre's CD-1215T is a portable 20-inch LCD monitor ($3,695).

PIXELINK'S SEXY PLASMA PANEL

For a really big picture on your data, consider Hudson, Massachusetts–based Pixelink Corp.'s new **Pixelink PX42,** a flat-panel display based on Fujitsu's 42-inch-diagonal color plasma display. This panel employs HDTV's 16:9 aspect ratio, so its 852-by-480 resolution is equivalent to a wide-screen version of a VGA-resolution (640-by-480) screen. Priced at around $15,000, the PX42 is meant to compete with data projectors in corporate boardrooms.

The display is based on Fujitsu's 42-inch color plasma panel, the first of its size to enter mass production. Since the panel uses light-emissive technology—the plasma excites phosphors, which then glow—you get a wide viewing angle in all directions, just as with a CRT. The big difference is that the 42-inch display is about 5 inches thick and weighs 85 pounds, which makes it suitable for mounting on a wall.

Since the light for each pixel is generated at that specific spot (as with an LCD panel), there are no problems with convergence or image geometry. The panel is capable of producing 16.7 million colors, placing it on a par with many active-matrix LCD panels and making it suitable for full-color displays. The red, green, and blue subpixels are arranged in vertical stripes, as in a Trinitron slot-mask CRT display.



Pixelink's 42-inch plasma panel is perfect for presentations (around $15,000).

The Pixelink implementation of the Fujitsu panel offers a standard VGA input as well as S-Video and Composite Video interfaces. The VGA resolution—albeit in a wide-screen format—is coarse compared with other higher-resolution displays that are typically used. The resolution is perfect for viewing video and computer-based presentations, however.

Images from the panel are generally clear, and colors show well. Plasma panels generally have problems with *contouring,* which shows up as pixelization and improper shading when large areas of color move on the screen. The Fujitsu panel shows some of this, but an error-diffusion algorithm reduces the effect to subtle levels.

The panel shows text and graphics well, even from 40 feet away. Improvements made by Fujitsu in this third generation of the panel have raised the brightness to near-LCD levels. Fujitsu reports that production of this panel is ramping up quickly, so look for prices to come down as much as 30 percent by 1998. □

FUTURE MASS STORAGE

Magnetic, optical, and holographic technologies will offer endless storage.

By M. David Stone



Since the first electronic computers in mid-century, the story of computer storage has been one of steady growth in capacity with shrinking sizes and prices. As recently as 1984, the 20MB hard disk on the original IBM PC seemed to be enough for any user. Today, the typical desktop capacity is closer to 100 times that: 2GB. With this rate of growth, a typical desktop system in a dozen years will offer 200GB of storage.

Whether that 200GB storage medium will be a descendant of the Winchester magnetic disk drive is open to debate. Even when hard disks hit their limits—something that may happen in the next ten years—there's plenty of room for growth in other technologies. Some technologies, such as holographic storage, are still in research labs but look increasingly practical. Others, such as storing data in a pattern of individual atoms by moving the atoms with a scanning tunneling microscope, are better understood as intriguing possibilities than as immediate storage solutions.

A number of schemes that look promising now will surely turn out to be dead ends, but others will just as surely pan out. However you look at it, the future for storage seems expansive.

The trend to greater capacity is built on the ability to squeeze more and more bits into any given area, a measure known as *areal density*. There are physical limits to how much information you can shoehorn into each square inch, which means the trend has to level off at some point. But we're nowhere near that point yet.

The hard disk has come a long way since IBM introduced its 305 RAMAC (Random Access Method of Accounting and Control) 40 years ago. The 305 RAMAC used 24-inch platters (50 of them), was roughly the size of two refrigerators, and offered 5MB of storage at $10,000 per megabyte. Areal density was 2 kilobits or 256 bytes per square inch.

By the time the first IBM PC came out in 1981 (without a hard disk as standard equipment), you could find 5MB drives that fit in a full-height 5.25-inch bay for about $1,000 per megabyte. Areal density had climbed to 2 megabits per square inch. Today, areal density is better than 500 megabits per square inch, and some PCs offer up to 1.4 gigabits per square inch—or 175MB on the area of a postage stamp. The cost is about 10 to 15 cents per megabyte.

INSIDE

TAPE BACKUP SOFTWARE
15GB 8-MM TAPE CARTRIDGES
FLASH MEMORY
DVD

The primary route to improving density during the next five years is to improve the sensitivity of the read head. And much of the recent improvement in areal density has come from the move to MR (magnetoresistive) heads, which are more sensitive than the older thin-film inductive heads. MR heads are still new enough to have plenty of room for straightforward, evolutionary improvement.

In December of last year, for example, IBM announced that it had reached a density of 5 gigabits per square inch by using an MR head. This laboratory demonstration used essentially the same technology as today's drives, reports Ed Grochowski, program manager of storage devices at IBM. The company expects drive capacity to grow three- to fivefold in as little as two years, and as much as tenfold by 2002. Street prices will fall to 3 cents per megabyte by the year 2000.

When MR heads bump up against their limits, still more sensitive heads, called *spin-valve heads*, will be waiting in the wings. Spin-valve heads depend on something called the *giant magnetoresistive effect* (GMR)—discovered only in 1988—which uses various thin-film layers to produce a greater change in resistance and thus the greater sensitivity.

Spin-valve heads will likely take over from MR heads for densities greater than 5 gigabits per square inch and will probably take hard disks up to at least 10 gigabits per square inch.

Another benefit of increasing areal density is that it also improves performance: As you pack bits closer together, the head can read more, more quickly, because more bits pass under the head. A 4,500-rpm disk with a high areal density actually offers a faster throughput than a 5,400-rpm disk with a lower areal density.

But rotational speed isn't standing still. Most drives today spin at 4,500 or 5,400 rpm, the fastest at 7,200. This year we'll see the first 10,000-rpm drives (the Seagate Cheetah is reviewed here). Interfaces, of course, will also have to get faster so they won't become a bottleneck. Fiber Channel, 1EEE 1394 (FireWire), and Serial Storage Architecture (SSA) could replace SCSI as the high-performance interfaces of choice, though the SCSI road map shows improvements coming there, too.

The ultimate limit for hard disk capacity is a hot topic among disk engineers. As the bits, which are magnetized areas on

the disk, get smaller and smaller, they will eventually reach a point where the energy required to retain magnetization is equal to the thermal energy of the environment. In other words, if you have small enough magnets, the magnetic fields in effect won't be stable at room temperature.

This limit, called the *superparamagnetic limit*, lies at an areal density somewhere between 50 and 100 gigabits per square inch, a level that we are likely to reach within the next ten years. There are two schools of thought about this limit. One says that it's the end of the road for magnetic disks. The other says that the limit will be extended with new materials or new structures for the disk. A structure that isolated each magnetic domain from its neighbors, for example, would make the domains more stable. According to Ed Grochowski, there is a lot of optimism that the limit can be extended.

OPTICAL DISKS: SEVERAL ROADS AHEAD

The immediate future for optical disks is set in concrete. The big news here is DVD, which is likely to dominate the action for the next few years as DVD's various flavors take over from CD-ROM and CD-R drives in the PC arena (for more information see "21st-Century Storage," *PC Magazine*, January 21, 1997). For storage, DVD-RAM disks, expected early in 1998, initially will offer capacities of 2.6GB.

The first-generation DVD-RAM specification uses phase change technology; it's not certain, however, that this will remain true for later generations. Magneto-optical (MO) technology is a viable alternative on this evolutionary path, and a somewhat unknown specification—MO7—eventually may challenge phase-change DVD-RAM.

As the name implies, MO7 drives use MO technology with a capacity of 6 to 7 gigabytes per platter. Unlike current MO disks, which employ the 5.25-inch format, the disks MO7 drives use will be 120-mm disks, like CDs and DVDs. MO7 drives can be designed to read DVD disks.

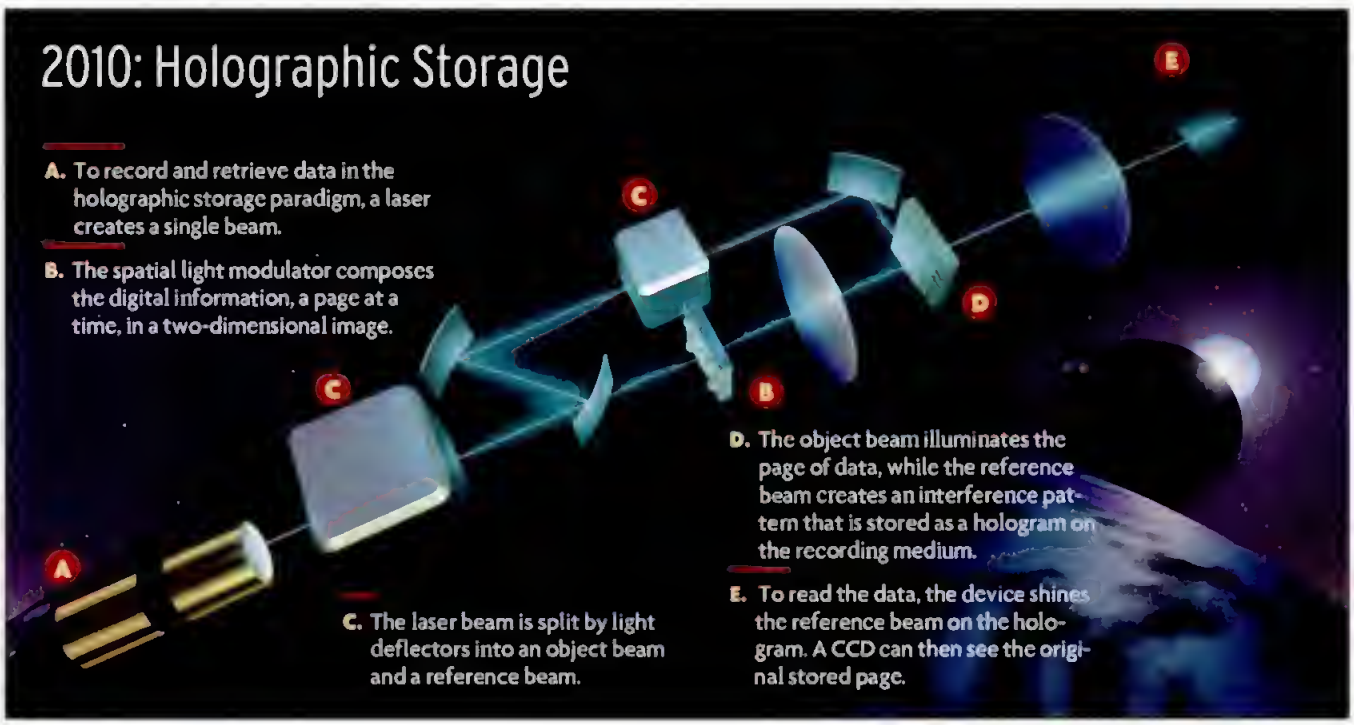
Will later generations of DVD-RAM use phase-change or MO technology? The answer will likely depend on which technology increases areal density faster. One route to increased density is multiple layers. Phase-change technology has the advantage here; it needs only to solve the problem of how to adjust the laser to affect the right layer. MO drives need to control both the laser and the magnetic field, since its reading and writing abilities rely on both. Conversely, Sony has demonstrated a technique called *magnetic resolution* that will let MO drives write smaller bits, which will increase areal density without extra layers.

There are other reasons why you can't count out MO drives just yet. In addition to the battle for dominance of 12-centimeter disks, there is likely to be a separate battle for 3.5-inch or smaller formats. As John Freeman of Strategic Marketing Decisions points out, the CD-size disk is too large for convenient portability. DVD-RAM technology may also show up in a smaller disk size, with an 8-centimeter format already defined (if largely ignored). But 3.5-inch MO technology has a big head start.

As we look 10 to 15 years ahead, further improvements in areal density will depend largely on progress with lasers. Shorter-wavelength lasers, using frequencies in the green and blue range, will work with any optical technology to give each bit a smaller spot on the disk. As with hard disks, a higher areal density will go hand in hand with improved performance. Designing shorter-wavelength lasers, however, is a challenge that has yet to be met.

TAPE: THE BEST IS YET TO COME

Tape has long been the most popular choice for backing up, because it offers the lowest cost per megabyte of any storage medium. But the sequential nature of tape, and hence its slow performance, has made it a poor choice for primary storage. The most interesting possibilities for tape



in the next few years are schemes that will make tape more like a random-access medium—with the hope of eventually making it just as fast as a disk for retrieving or writing files.

There are already some steps in this direction with PGSoft's Tape-It and Seagate's Direct Tape Access (the latter is reviewed here). Both of these programs make your tape drive look like a disk drive to your operating system. Loading a file can still take several seconds rather than the milliseconds we're used to with a hard disk, because the drive first has to wind the tape to the beginning of the file. But saving files is a snap, since the software saves to RAM or hard disk, then transfers files to the tape.

More sophisticated tape schemes are under development. The Eagle Division of Exabyte, for example, is working on a solution that it hopes will give instant access to files on a tape drive, at least for large files such as video clips. The scheme automatically will create reference areas on the tape. These reference areas will include enough frames from each video clip to give the tape time to reach a file while your system plays the first frames. Other companies are working on schemes that will use tape for primary storage and use the hard disk strictly for caching.

Part of the tape's success in the coming years depends on faster performance, so you can get the data off the tape quickly enough to compete with hard disk speeds. Look for a move to MR heads and servo tracks (extra tracks that help the drive find the data tracks) in tape drives, eight-channel heads (as opposed to the one-channel heads used by most current tape drives), and digital rather than analog channels, to give even inexpensive tape drives higher transfer rates and better reliability.

In the five- to ten-year time frame, the move to 16-track heads is a predictable improvement. Beyond that, the laser technology currently in optical drives may make it to tape, producing optical tape. Bob LiVolsi, vice president and general manager of Exabyte's Eagle Division, puts optical tape in the five- to ten-year range. Others would argue that ten years is the more realistic number.

An optical tape drive would boost both capacity and speed significantly compared with magnetic tape. And as LiVolsi points out, given reference areas duplicated throughout the tape, storing data on optical tape could be indistinguishable from storing it on-disk. This may be a rosy picture, but it certainly explains why Exabyte views tape as something whose time is yet to come.

EMERGING TECHNOLOGIES

Certainly the most intriguing emerging technology is *holographic storage*, which seems on the verge of becoming practical. A common refrain in the industry is that it's hard to predict what storage will look like in 10 to 15 years; by then, holography could change the world completely.

The basics of holographic storage are simple enough. First, you compose a page that represents the digital information as a two-dimensional image, using a device called a *spatial light modulator* (SLM). Then you create a hologram of the image.

Creating the hologram involves optically splitting a laser beam, then using mirrors to direct the split beams. One beam, called the *object beam*, illuminates the page before it joins with another beam, called the *reference beam*, to create an interference pattern that's recorded as a hologram. To read the data, you simply recreate the reference beam and shine it on the hologram to reproduce the image of the page. It's no trick at all to read the image with a CCD array, which is simply an array of photodetectors.

Holographic storage has all sorts of advantages. To begin with, holograms aren't stored as pictures but as wave-interference patterns. If you cut a hologram in two, you don't get two halves of the image; you get two whole images. For storage, that means a defect in the storage medium won't wipe out any data. The information is stored redundantly throughout the hologram.

You also can store multiple holograms in the same place, or volume, by varying the laser's angle or wavelength. Since each page can hold more than a million bits and you can, in theory, store thousands of pages in a dime-size volume, the potential volumetric density (the closest equivalent to areal density) is measured in terabits—trillions of bits. And since holographic storage will read a full page at a time, performance also promises to be impressive.

Even more exotic than holography are two possibilities that depend on something called *proximal probe techniques* using an *atomic force microscope* (AFM) or *scanning tunneling microscope* (STM). AFM schemes use a heated tip to burn pits on a surface. The pits are so small that they are measured in nanometers (billionths of a meter) and have a theoretical maximum areal density measured in hundreds of gigabits per square inch. STM techniques represent the ultimate storage scheme, moving individual atoms around to represent bits. Both possibilities right now are strictly at the level of basic research.

The preferred storage solution for 15 years from now remains unknown, however. It could be any possibility mentioned here. Or it could be something else altogether. Exabyte's Bob LiVolsi suspects that we haven't yet seen the invention that will serve as storage in the year 2010. He may well be right.

CD and DVD Compatibility: Will This Play That?

The road from read-only CD-ROM to rewritable DVD-RAM is mapped out clearly. Less clear is the interoperability of the various disk formats in between. This grid shows the drive types and which formats they will support, according to the Optical Storage Technology Association (OSTA).

DRIVES	READ	WRITE	CD-ROM disks	CD-R disks	CD-RW disks	DVD-ROM disks	DVD-R disks	DVD-RAM disks
CD-ROM								
CD-recordable (CD-R)								
CD-rewritable (CD-RW)								
DVD-ROM								
DVD-recordable								
DVD-random-access memory (DVD-RAM)								

* Not all manufacturers' drives will read this format. Check the specifications before you buy

ILLUSTRATION BY STAVA

What part of your life are you willing to risk?

Your financial records?

Your email?

Business correspondence?

Your business files?

Your personal files?

Your applications?

Funny articles off the Internet?

Your type fonts?

Your personal organizer?

Your games? (Yikes!)

Love letters?

Your kid's sports schedule?

Budgets?

Your stock portfolio?

Meeting notes?

Faxes?

Medical history?

Did we mention your financial records?

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EMERGING MASS STORAGE

EVEN FASTER AND SMALLER

DVD finally makes its appearance, but advances in tape, hard disk, and PC card devices ensure continued market diversity. **By M. David Stone**

As in the past, the future of mass storage shows a variety of technologies existing and evolving side by side. In these reviews we glimpse the latest in tape and hard disk solutions. We also try out Intel's answer to the need for miniature removable storage for portable devices, and we test one of the first available DVD-ROM drives.

SEAGATE'S BETTER TAPE BACKUP

There's a new kind of tape drive software in town. Seagate Technology's **Seagate Direct Tape Access 2.05** (the first shipping version) is the most recent example and only the second program of its kind. The whole point of DTA, like PGSoft's Tape-it, is to make your tape drive look like a disk drive to Microsoft Windows,



Seagate Direct Tape Access, a software utility, gives quicker access to tape-based files.

freeing you from having to use dedicated backup software to store or retrieve files. DTA is available now for Windows 3.1 and Windows 95 ($89 list, $60 street) and is also bundled with selected drives from Hewlett-Packard, Iomega, and Tandberg.

To back up, you copy files to the tape drive using File Manager, Explorer, XCOPY in a DOS window, or the copy command in any other program. To replace lost or damaged files, you use any program to copy the files back from the tape.

Since the storage medium is still sequential tape, DTA may take seconds or tens of seconds to find a file and start loading it, or to find the right place on the tape to start saving a file. But the wait is acceptable for large files that you load only occasionally. This software made our tape drive much more inviting to use for near-line storage, since we didn't have to launch a program such as Seagate's Backup Exec and execute a Restore command.

Moreover, we had expected that using a tape drive as a disk would be a little like going to see the wonderful dancing bear, where the wonder is not how well the bear dances but that it dances at all. In tests with a Travan-3 tape drive, however, the DTA approach worked more quickly and more smoothly than we had anticipated.

The bear, it turns out, dances pretty well. And there's a good chance that DTA, or something similar, will soon replace or supplement backup and restore programs for most tape drives.

EAGLE'S HIGH-FLYING VIDEO ON TAPE

The **Eagle DigiMax**, from the Eagle Division of Exabyte Corp., is a new kind of 8-mm tape drive in more ways than one. The drive (available this fall for less than $500 on the street) delivers 13GB native capacity on each tape cartridge. More intriguing, it's optimized for MPEG-2 video. The capacity, performance, and low cost per megabyte make the DigiMax a contender for video-archiving applications now dominated by optical storage paradigms.

Among the DigiMax's leading-edge features is a magnetoresistive head that reads and writes eight tracks (or what Eagle calls *channels*) at a time. According to Eagle, the tracks allow enough redundancy that you can lose more than a full track without losing data. The tape itself includes permanent servo tracks to maintain alignment; this allows thinner—and therefore more—data tracks across the 8-mm width of the tape.

Among its MPEG-2 optimizations, the drive varies tape speed to match the rate of incoming data as the level of compression varies from one moment to the next. Eagle claims the 2-MBps (2-megabyte-per-second) maximum throughput is fast enough to keep up with video recording or playback even with minimum compression.

The DigiMax is also a removable drive that comes with a mounting kit, or Nest. Once you install the Nest in a 5.25-inch drive bay, you can slide the drive in or out of the bay to move it from system to system. Additional Nest bays should cost less than $100 each.

Eagle sees the real future of this drive in video storage. It believes that the next few years will see video e-mail become popular both in the office and for personal use. If that happens, storage needs will go through the roof, and the DigiMax will be ready as an inexpensive, high-capacity drive that can record and play video directly to and from tape. Video playback quality from the unit we tested was nearly flawless, with no noticeable breaks.

Eagle has high hopes for subsequent iterations of the DigiMax as well. Eventually, it may serve as a VCR for a TV or the much-discussed combination PC/TV—for taping TV shows, browsing through downloaded Internet files on a Web TV, and even downloading pay-per-view movies.

With its ability to store video economically and deliver it smoothly, the Eagle DigiMax shows that the repeated



Seagate's Cheetah hard disk hits 10,000 rpm.

TUESDAY
October 8, 1996

The Daily Monitor

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EIZO NANAO WINS AGAIN!

Back To Back Nod For Monitor Maker

By Rez O. Looshun
MONITOR STAFF WRITER

LOS ANGELES — It's an announcement that is becoming all too familiar. EIZO Nanao Technologies has once again taken home the coveted Editor's Choice Award from PC Magazine.

This sixth award in the past six years goes to the company's FlexScan® TX-C7S 17-inch class color monitor. It's an honor that carries particular significance as it cites superiority in the judging category having the toughest standards.

"The TX-C7S monitor's image was especially sharp and clear, with no detachable faults," said a PC Magazine judge.

Not too surprising for EIZO, though. The company's monitors previously earned Editor's Choice accolades in 1990, 1992, 1993—for its FlexScan 9400, F550iW and FlexScan F340iW monitors—and last year for its highly regarded FlexScan T2-17TS model.

PC MAGAZINE EDITORS' CHOICE™

October 8, 1996
FlexScan TX-C7S

TX-C7S Lauded as 'Best of the Best'

By E.Z. Viewin
MONITOR STAFF WRITER

LOS ANGELES—Words such as "unbeatable," and "top flight," have been flying around town ever since EIZO Nanao's FlexScan TX-C7S 17-inch class color monitor walked off with the 1996 PC Magazine Editor's Choice Award.

With this key award under its belt, the FlexScan TX-C7S figures to be the monitor of choice for graphics and business professionals who demand crisp, true-to-life colors and stable screen images for desktop publishing, 24-bit imagery, high-end graphics and multimedia applications.



This year's big winner: The FlexScan TX-C7S 17-inch class color monitor.

Editor's Choice: The Award That Shapes Industry Thinking



It's deja vu all over again: EIZO Nanao has now won six Editor's Choice Awards in six years.

By Mona Turr
MONITOR STAFF WRITER

LOS ANGELES—Winning a PC Magazine Editor's Choice Award tells the world of hungry hardware buyers that you've arrived in a big way.

"It's the one award we all dream about, the one we covet more than any other," said N.V.S. Guy of Silicon Valley's LuzerCom.

EIZO Nanao monitors have earned worldwide recognition for dependability, cost-effective performance and pleasing, ergonomic design. In fact, I'm going to stop writing this story right now so I can call EIZO Nanao Technologies at **1-800-800-5202**. Then again, I could get an informational fax on demand by calling **1-800-416-FLEX.** Either way, like the TX-C7S, I'm a winner.

EIZO
PRODUCED BY NANAO

EIZO is Nanao's *New* Universal Brand Name
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Close your hand around the new Microsoft IntelliMouse®. Right beneath your index finger is a raised rubber Wheel. In Microsoft Word 97 roll the Wheel forward. You zip up toward the top of your document. Roll it backward and you zip back toward the end. Roll it slowly to move just a few lines at a time. This is how the new IntelliMouse works with new Microsoft Office 97 and lots of other IntelliMouse-compatible programs to make getting your work done easier.

Go to Microsoft Excel 97. Press the CTRL key and push the Wheel forward or backward. You zoom in closer or zoom out farther. See how manageable even a massive spreadsheet becomes.

A final touch.

To scroll through Web pages with Microsoft Internet Explorer, press the Wheel once and move the mouse downward. Your computer goes into AutoScroll mode. Automatically, rolling line by line through your entire document. Without even lifting a finger.



Microsoft

Microsoft® IntelliMouse

Where do you want to go today?® www.microsoft.com/hardware/

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reports of tape's demise have been greatly exaggerated.

CHEETAH HARD DISK SPINS FASTER

Most 3.5-inch desktop hard disks spin at a stately 4,500 or 5,400 rpm. High-performance drives for server and video applications top out at 7,200 rpm. Seagate Technology's new 4.5GB **Cheetah 4LP** boosts performance to a dizzying 10,000 rpm. Expect to see Cheetah drives appearing in server configurations this spring; future iterations should find their way into high-end PCs.



Intel's mini flash memory.

Ultimately, hard disk performance depends on *access time* (how quickly a drive's head can get to the desired data track and sector) and *throughput* (how fast it can siphon off the data and pass it along). The drive's rotation rate affects both.

To increase access time you want to lessen a drive's *latency*—the time it takes to move along the track to reach the file. Seagate claims an average latency of just 3 ms (milliseconds) for the Cheetah, versus 4.2 ms for the best 7,200-rpm drives, and a total average access time of 7.5 ms (versus 8.5 ms). The bottleneck in throughput is usually how many bits the head can read, based on how many it passes over in a given amount of time. The faster you spin the disk, the more bits can be read.

Seagate claims a throughput of 11 to 16.8 MBps (megabytes per second) for the Fast-20 SCSI Cheetah. The drive will also come in 8-bit Fast-20 and Fiber Channel versions.

If nothing else, the Cheetah series demonstrates that the performance of traditional hard disks can continue to improve.

INTEL'S ULTRA-MINI SOLUTION

If you have any doubts whether storage can get any smaller, you need only take a look at the **Intel Series 100 Flash Memory Miniature Card** (MC), which has about ten manufacturers besides Intel committed to producing more of the same. This new choice in miniaturized storage is about the size of a matchbook (the street price should be about $45 for a 2MB cartridge, $75 for 4MB).

Today's MCs are meant to provide an easy route to merging computers with such consumer electronics as cameras and audio recorders. With the Konica Q-EZ digital camera we tested, for example, the MC makes moving images from camera to PC a snap—or series of snaps. Snap the MC out of the camera, snap it into a PC Card adapter, and plug the adapter into a PC Card slot. Your PC sees the MC as a drive, so you can open, edit, and print the files.

You can do much the same with audio, using an MC to replace tape. Dictaphone, Grundig, Olympus, and Philips are all developing MC recorders, according to Intel. Other strong candidates for using MC cards include Web TVs, cellular phones, global positioning systems, handheld games, and handheld PCs.

In addition to 2MB and 4MB capacities, Intel expects to offer 8MB and 16MB MCs this year, with the specification allowing up to 64MB in this compact size. The current 4MB capacity is enough to hold 20 compressed digital camera images (at 640-by-480 resolution) or about 30 minutes of audio.

Finally, note that MC is one of several competing formats for miniaturized storage. SanDisk and Toshiba are introducing similar cards based on different standards, and Iomega is developing a 20MB miniature cartridge called n-hand, which should cost just 50 cents per megabyte. It's an open question whether these will all survive or whether one will wind up as the ultimate winner.


Toshiba's prototype DVD-ROM drive.

TOSHIBA SPINS UP DVD

DVD seems finally ready to get moving. Toshiba America Information Systems likewise is ready with its **Toshiba SD-M1002**, which should be available in new PC systems by the time you read this. The cost to PC manufacturers starts at $350, which means end users should expect a $400 to $600 price premium on a PC configured with this drive in lieu of a standard CD-ROM drive.

For this roundup, Toshiba provided a preproduction unit. Granted that DVD-ROMs are an evolutionary step up from CD-ROMs, it's physically similar to a CD-ROM drive. It fits in a half-height 5.25-inch bay, uses an ATAPI interface, and holds the disk in a slide-out drawer.

DVD-ROM disks can hold 4.7GB of data per side and eventually will house 8.5GB per side with dual layers. The first crop of DVD-ROM disks will use just the 4.7GB format. But the SD-M1002 (and all announced first-generation DVD-ROM drives) will read the 8.5GB format as well, plus standard CD-ROMs and audio CDs. Toshiba points out, however, that these first-generation DVD drives will *not* read Photo-CDs or CD-R disks—an inconvenient restriction. Buyers may want to configure new PCs with both DVD drive megabyte and CD drives.

In DVD mode, Toshiba reports that the SD-M1002 delivers a sustained throughput of 1,350 KBps (kilobytes per second) and a 220-ms average access time. We don't yet have DVD-based performance tests, but we were able to test the drive's performance with traditional CD-ROMs. On the WinBench Sequential Read test for CD-ROM throughput, we clocked the SD-M1002 at 1,210K per second (KBps) sustained throughput—better than the 1,200 KBps claimed for the drive in CD-ROM mode. Average access time was 156 ms rather than the claimed 120 ms (but keep in mind that this was a preproduction unit). All told, the SD-M1002 does what it promises. It moves DVD one step closer to being part of your future. □

FUTURE AGENT SOFTWARE

Intelligent software will personalize the Web and make it work for you.

By Richard V. Dragan



Sure, the truth is out there, but on the Internet, it's hard to find. With millions of Web pages, getting what you want is now more difficult than ever. For users baffled by information overload, the Web has become more than a little anonymous. The solution to this problem may lie with agents, which have the potential to transform the nature of Web surfing and make it a more personal, productive, and lucrative enterprise for users and vendors.

As agents come of age, you can expect highly personalized content for entertainment, news, products, and other links to appear automatically on your favorite Web sites. This personalizing will happen behind-the-scenes using agents.

INSIDE

AUTONOMY AGENTWARE
EXCITE NEWSTRACKER
FIREFLY TECHNOLOGY
LIVE AGENT
THE AGENTS OF THE FUTURE

Sophisticated agents can learn on their own by following your example. They can watch how you browse during a session and discover what you might be interested in, tailoring their behavior accordingly.

Searching for plane tickets, a stock bargain, or a good book? As commercial agents appear, they'll be able to hunt down just what you want. If properly authorized, they'll even place orders and charge your credit card for you.

Agent development is being driven by a number of aggressive start-up companies and backed up by leading-edge academic research in computer science. The world of agents is clearly heating up.

The term *agent* has been used in computer science for more than a decade now, and it means a lot of different things to a lot of intelligent people. In its simplest form, an agent is a piece of software that does something for you. But by this definition, wizards, assistants, and even spell-checkers could be called agents.

You expect agents to automate repetitive tasks. On the Internet, agents were first used to catalog millions of pages of content. Search engines such as Lycos used *spider agents* to handle the tedious task of searching the entire Web.

Now that we have search engines producing hundreds of hits for almost any conceivable query, the problem is knowing what users are really interested in. This is where the agents of the present and very near future will make the greatest impact. *Personalized content*—delivering just what you want—is the goal of many of the agent technologies considered here, and many strategies exist for trying to provide it.

Agents are somewhat indebted to certain technologies from the 1980s that never caught on. Such technologies—namely, artificial intelligence (AI) and expert systems—failed to live up to high expectations.

The next generation of applied research—in the form of agents—has a greater likelihood of success, because it involves new models of computer "intelligence." New technologies such as *collaborative filtering* (developed by Firefly and Net Perceptions) offer a productive model that fits within an extraordinary range of consumer tastes. Your interest in media (such as books and CDs) or content (such as news stories) can be ascertained with collaborative filtering.

Where the older AI technology tried to make computers think like people (which had only limited success), collaborative filtering applies human thought—a database of user preferences—to new items with extraordinary powers of prediction. This consumer-centered approach is a hit with many Webmasters and has obvious applications for catalog and content-based sites.

Traditional AI approaches are still available, too. Several agent products use research in areas you've possibly never heard of, such as neural networks, fuzzy logic, natural-language processing, and collaborative filtering. For example, to accomplish pattern recognition and visual processing, agents might use neural networks, which in turn use parallel processing (one of the staples of cognitive science and AI).

Meanwhile, fuzzy logic supplies computers with sufficient data to codify fine distinctions that people make all the time (such as the concept of "warm" rather than "hot" or "cold"). Natural-language processing allows computers to operate using English-like statements instead of arcane programmer-oriented language. Autonomy's client-side program uses natural-language queries to learn the information you want.

ANCHORED VS. MOBILE AGENTS

You can classify agents into two groups based on where they reside and where they do their work. *Anchored agents* do most of their work on either the client side or on the server side. The client utilities from AgentSoft and Autonomy are two examples of this approach. These programs run alongside your browser

and automate browser sessions.

Of course, these clients still work with Web servers; that's where they do their searching. But they remain more or less anchored on the client's machine. For Web pages that make use of agent technology (such as Firefly), the intelligence is placed on the server side.

Mobile agents make up the more sophisticated group and have the most promise. These agents, which resemble some kind of software robot out of science fiction, can move themselves from server to server to find what they need. They are executing programs that carry their state information with them, making them self-contained.

Today, it's natural to think of programs grabbing resources from remote spots on the Web, but to have a program jump to another server is a novel idea.

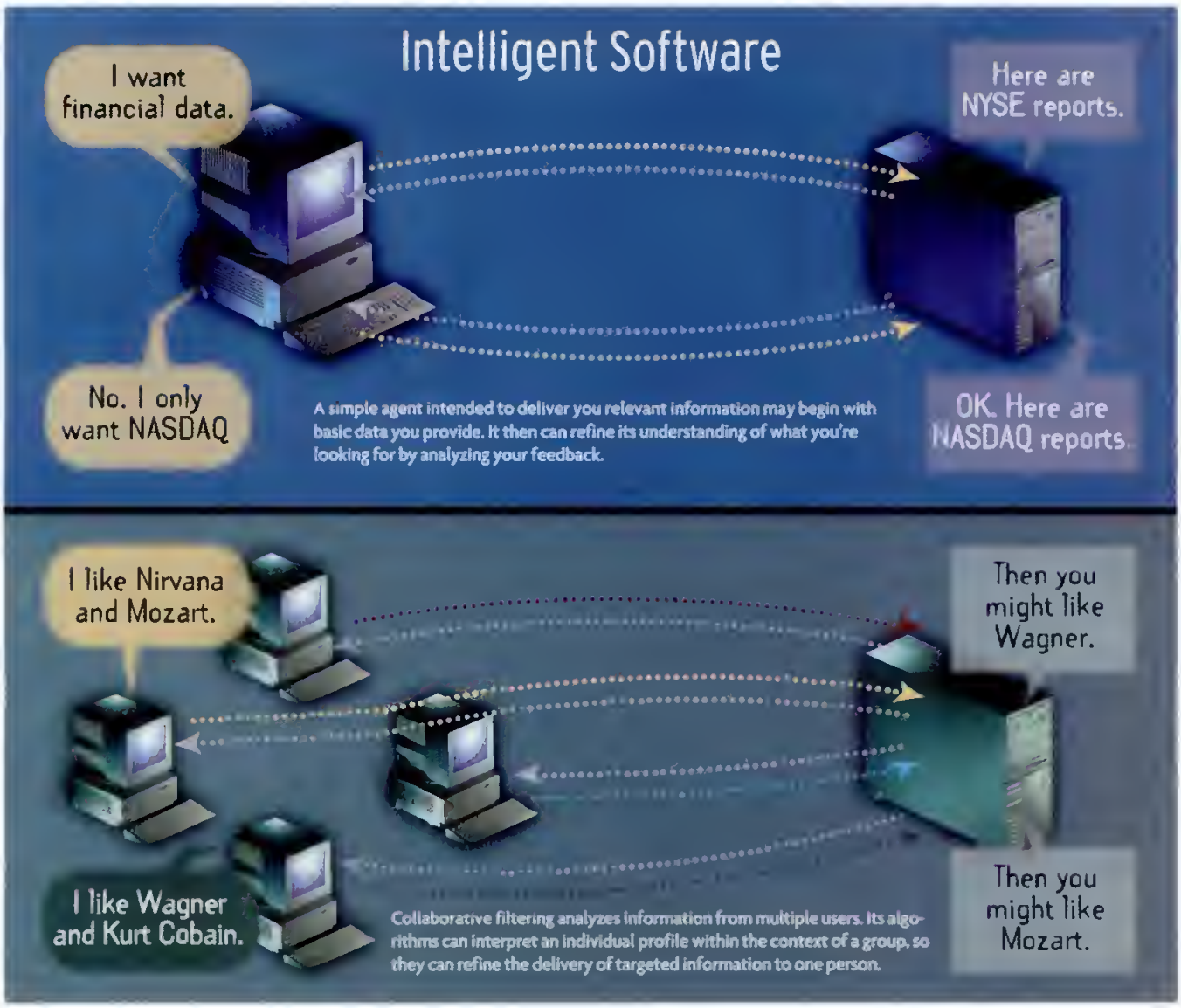
DEALS IN CYBERSPACE

This approach, pioneered by General Magic and implemented in its proprietary Telescript programming language, offers perhaps the most potential for commerce on the Web. Agents for buyers and sellers could meet on the Web and actually make deals in cyberspace. These agents could search the Internet for a desired product and price, even ordering the product automatically by using your credit card number. Many vendors are drooling over the prospect of having autonomous agents hunt down bargains.

For this approach to be used over the public Internet (it's currently being used on intranets), standards definitions for such commerce (principally, security) need to be implemented. For agents to work properly, servers of all kinds would need to be able to run mobile agents safely and securely.

Without broad support for standards, there's no way an agent could move around from server to server. Nevertheless, this vision holds a lot of potential. A host of useful business applications awaits, but time will tell if this technology can become widely accepted.

It has always been true that today's science fiction is tomorrow's fact. You can expect the line to blur even further as agent-enhanced Web tools become standard equipment and standard operating procedure for us all.

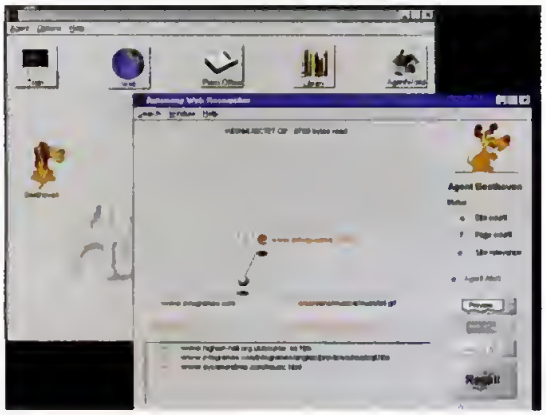


EMERGING AGENT SOFTWARE

TAMING THE WILD, WILD WEB

Vendors rush to market with sophisticated and powerful network agents that are easy to use and eager to please. **By Richard V. Dragan and Andrew Boscardin**

The Web is an obvious place for agent technology to develop. All those sites. All that information. But users have only so much time—and patience—for browsing. It's interesting to see the different ways in which the technology is being implemented—from a personalized agent that reacts to your choices to customizing news delivery to applying the idea that groups of people who all like one thing will probably have other things in common. Each one is effective and hints at where agents may be headed next.



AgentWare's agents do searches for you using English-like statements.

AN ACCOMMODATING AGENT

A playful, easy-to-use interface masks sophisticated agent technology in Autonomy Inc.'s **AgentWare 1.0** ($49.95 list). This powerful client-side agent tool provides an appealing and useful demonstration of what agents are capable of doing. Using neural networks, fuzzy logic, and natural-language processing, this standalone program offers considerable power for automating Web searches you'll run again and again.

AgentWare's interface is geared toward users of all levels. Agents are represented on the desktop by friendly-looking dog icons. The program includes about 40 predefined agents that cover diverse topics such as entertainment, politics, and science.

Creating a new agent is easy. You name your agent and use natural-language queries to describe what you're looking for. You sift through the results and tell your agent whether they match with what you had in mind. AgentWare then refines its search based on your feedback. On our testing, we found that AgentWare's learning capability wasn't always perfect, but it did manage to narrow our searches most of the time.

You search the Web by dragging one of your agents onto the Web icon. This calls up the Web Researcher, which shows you the progress of a search as it works its way through the Web. Once you get your results, you can display them in a variety of browsers, including Netscape Navigator 2.0 and 3.0 and Microsoft Internet Explorer 3.0.

Search results can then be added to the Autonomy library, which serves as a scrapbook of Web pages. You can also search this archive using such natural-language questions as "Show me all the articles about football."

AgentWare comes with the AgentWare Press Agent. This feature allows you to use a selected agent to search the Web sites of roughly 40 newspapers and magazines. This can speed up a search considerably if you're interested in locating specific articles rather than just any Web pages.

The kennel feature is one of AgentWare's most powerful features. You can tell an agent to begin searching a kennel and then go off-line. This way, you don't have to watch as the search progresses, which can sometimes be a tedious process. The actual search is conducted at one of Autonomy's AgentWare–enabled servers. Results can be retrieved and viewed at a later time. This feature seems to be exactly what you would want from an agent.

With its intuitive interface and natural-language abilities, Autonomy's AgentWare appears to have gained an excellent foothold in the world of agents. It stands as a highly useful and intriguing agent tool.

NEWS AT YOUR FINGERTIPS

Customizable news is one of the fastest growing services available on the Internet. Instead of relying purely on predefined categories and keyword searches to sort through the news wires, Excite Inc.'s **NewsTracker** (free) uses a personal agent to sort through the volumes of periodicals currently on the Web. Though it's one of the simpler examples of agent technology, NewsTracker does bring you news from more than 300 Web periodicals.

To use NewsTracker, you'll need a free Excite Live! account. Once you've created your personal page, simply click on News Tracker and configure your agent. You can add news and article topics from the list provided or create your own from keywords. A topic can be customized at any time by adding or removing keywords.

Once the agent is set up, it will search for your keywords in its database, sorting the results by keyword frequency. After you've read your retrieved articles, you can teach the agent which items you liked by clicking a check box. Your feedback is then used to narrow the next search.

Although the rating system is somewhat limited, the site does a good job of filtering out unwanted information sim-



When you indicate whether you liked an article retrieved for you, NewsTracker refines your query to deliver better results.



Whatever you're creating on-screen, Philips Brilliance monitors will bring out the best in you. The pixel perfect display offers you incredibly high resolution, color accuracy, contrast and consistency right across the range. They're available in 15", 17" and 21" sizes (13.7", 15.9", 19.9" VIS*), which means that whether you're a design professional, office or small business user, or even a gamer, we have the right kind of monitor for you. So why waste your talents on anything less? Look into a Philips Brilliance monitor today. For more information, call 1-800-835-3506 or access our Web site at http://www.philipsmagnavox.com.



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ply by pushing more desirable links to the top. At press time, Excite was preparing to launch a revamped version of News Tracker that should be online by the time you read this. With Excite's impressive database of URLs behind it, NewsTracker is a reliable way of making sure the news you want is right at your fingertips.

COLLABORATIVE FILTERING

Looking to buy a new music CD or rent a video? Firefly Network's **Firefly Technology** (free) can probably help—check out this server-based technology at Firefly's Web site (*www.firefly.com*). Using collaborative filtering, Firefly can accurately predict what music or movies you might enjoy by comparing your tastes with those of nearly a million users. Besides providing a useful service for consumers, Firefly Technology may be instrumental in developing agents that help us make online purchasing decisions.

Firefly's collaborative-filtering technology, which was developed at MIT's Media Lab, allows computers to learn based upon a community of users. Traditional models of machine learning, such as neural networks, do not factor in this social element. Community is not just a slogan at Firefly: It is the foundation for a powerful algorithm that filters users' preferences based on other users with similar interests.

Taste is subjective, but if you try Firefly out you'll probably be surprised at its accuracy. It is a very user-friendly Web site that claims many loyal members. Membership is free, and once you create an alias and password you'll be able to rate your favorite music and movies.



Firefly's agents will guess what you like based on the preferences of other users with similar interests.

Firefly has also licensed its technology to other Web sites. You can use Firefly to find software at the ZDNet site (*www.zdnet.com*) and Web sites if you use Yahoo's customizable news service, My Yahoo! (*my.yahoo.com*). Reuters New Media has also licensed Firefly Technology for filtering news stories to users. Firefly's technology can be used anywhere consumers make choices—the implications for advertising and catalog applications are obvious.

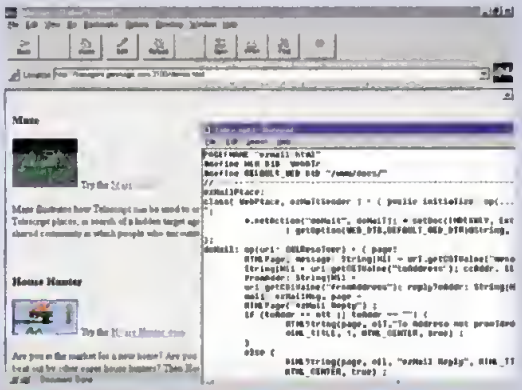
Firefly is developing a client-side utility that will enable its technology to work with the browser-enabled desktops of the near future (such as Microsoft ActiveDesktop). It's also packaging its technology in server-side tools so that more Web sites can take direct advantage of its

Building the Agents of the Future

General Magic's vision for agents is more ambitious than most. With its Telescript programming language and **Tabriz AgentWare for Windows NT 1.0** development toolkit (still in beta), it hopes to bring about a world where mobile agents conduct real commerce on the Internet.

Understanding what a mobile agent is involves understanding the notion of an executing software module (written in Telescript, a pioneering programming language used for creating agents) and the notion of *place*. A place is where an agent runs; it could be a Telescript-enabled server, a browser client, or even a wireless hand-held device such as a pager. Mobile agents are special because they are self-contained. As they move around the Internet, they carry along their state information (everything they need to run). Once they find an answer—such as a product for sale sold by another agent—they can report back to the original client or server.

Conducting business on the Internet might involve buyer and seller agents. These could seek each other out in cyberspace and then charge your credit card once the right product and price have been found. Agents may also play a strong future role in PDA and cellular technology. They could help overcome the limited interfaces of hand-held devices and assist in delivering voice mail, e-mail, or even Internet content.



Tabriz and the Telescript programming language combine to build agents for a variety of tasks.

Security obviously becomes an issue under this scenario. Agents are designed never to become worms (malevolent, self-replicating programs) because they work inside the confines of the Telescript virtual machine. Also, they can only run on Telescript-enabled servers (Java is prevented from causing problems for Java clients in much the same way).

The Tabriz development environment provides tools that let developers work with the hundreds of objects found in the Telescript library. Apart from handling security, there are objects to manage Telescript-to-Web and Web-to-Telescript transactions. Future plans for the product may include a COM interface to Telescript objects and Java support, but this is not yet final. In the meantime, Telescript provides some significant agent technology, and it is being implemented on intranets for several Fortune 500 companies.

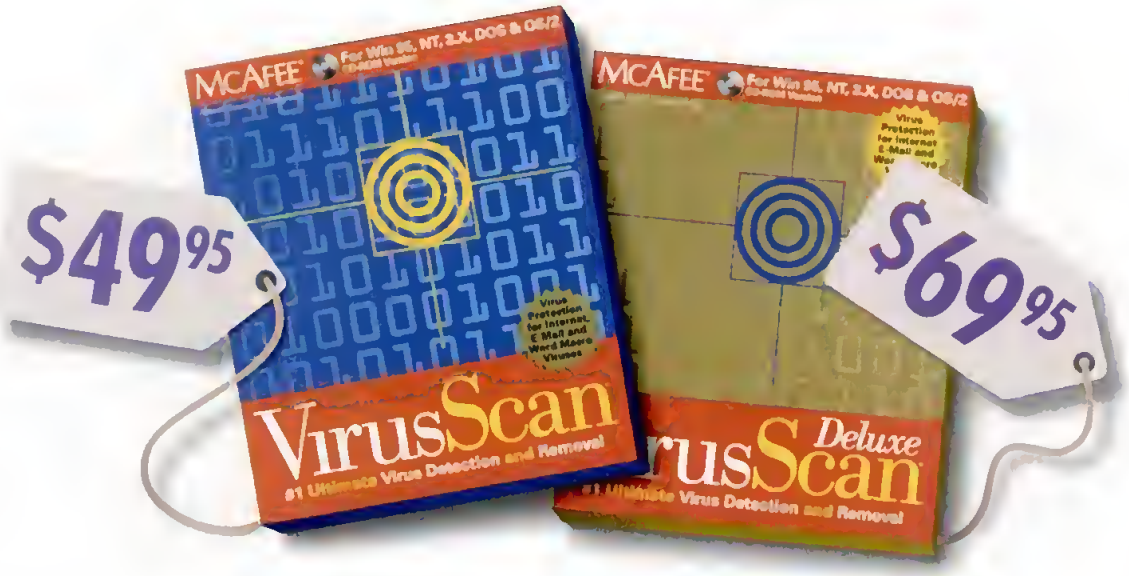
General Magic's Tabriz/Telescript technology will play a significant role as mobile agents come into their own on the Web.—*RVD*

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PERFECT VIRUS DETECTION.



Virus Bulletin, comparative NT review, 10/96 | *NCSA certification as of 1/97* | *VSUM certification, 12/96*

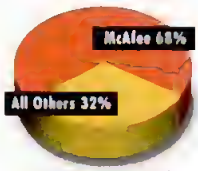
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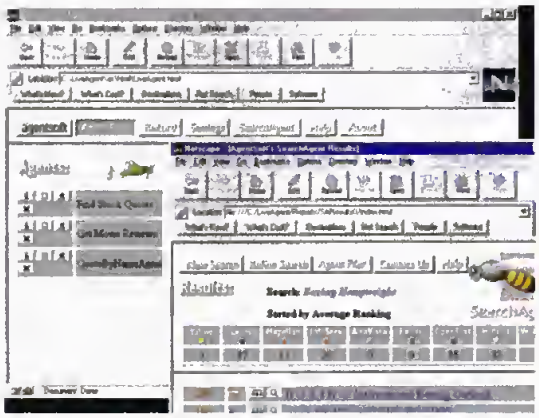
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*Test results based on Alwil technology and McAfee-Hunter engine. ** Prices shown are estimated street prices and may vary at your local retailers. †Worldwide anti-virus market share. Standalone DOS, Windows and OS2 shipments – IDC, 1994

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approach. The initial release of server tools will be in C++ and Unix, with Java and ActiveX support to follow. The technology will be as open as possible, and it will work on a wide variety of client and server platforms.

With its intuitive, powerful, and flexible agent technology, Firefly has created a useful, entertaining Web site. You can expect Firefly's model of agents to generate plenty of interest as commerce on the Internet takes off. (Softbank, the parent company of both *PC Magazine* and Ziff-Davis Publishing, is an investor in Firefly.)



LiveAgent's SearchAgent gathers the results of multiple search engines and eliminates duplicates.

DETECTING A PATTERN

You can automate some of your Web browsing and searching tasks with AgentSoft's **LiveAgent 1.1**. The beta version is downloadable for free, and the final release version is expected to sell for around $40. Its innovative features provide a compelling look at today's agent technology.

LiveAgent adds a separate frame interface with several buttons to your Netscape Navigator or Microsoft Internet Explorer browser window to help you better manage your Web tasks. You can start the recorder to save any sequence of browsing operations. Each step during the process, LiveAgent will ask you whether your action is something that should be automated (such as entering a user name and password for a log-on screen) or whether your actions are variables. It records your steps much as you would when creating a macro.

If you designate any value as a variable, you can change that entry when the agent is played back. For example, you can use this feature to obtain a stock quote based on a company's stock symbol. Then you can change the company each time you run that agent.

The program's agents run using Java and JavaScript, making them an interesting demonstration of the powers of Java. Once you record agents, you can manage them using the Agent Filer feature. This tool allows you to run any agent and write its results to a report using HTML. (As you browse pages, the gathered information is saved to HTML.) Although the interface takes some getting used to, it is clear that the basic record and reuse model of building agents can be a real time-saver.

LiveAgent also comes bundled with SearchAgent 1.0, a metasearching tool that offers many rich customization features. SearchAgent lets you automate queries on such major search engines as Excite, HotBot, and Yahoo! The matching results are then placed in HTML files. You also can control the sorting and filtering of the initial results. SearchAgent will apply the search rules you set for your query more reliably than the search engines do. For example, it will eliminate "John OR Smith" results that are usually retrieved with "John AND Smith" results. You can also specify the maximum number of matches or time spent searching. SearchAgent collates the results from multiple search engines and eliminates duplicates. In the beta version, performance on very large searches was somewhat sluggish during our testing (this is probably attributable to Java). You'll do better if you use only a few search engines at a time.

AgentSoft also provides a developer's toolkit for creating server- and client-side agent applications in LiveAgent Pro. This product includes Java libraries and source codes to help get developers going with agent-centered applications. You can also experience LiveAgent in sister company Accent Software's WebTamer, an off-line browser.

With its innovative use of Java, JavaScript, and underlying agent technology, AgentSoft enters the competition armed with a useful agent tool. It bears watching as this market matures. □

Perceiving Filtering's Next Direction

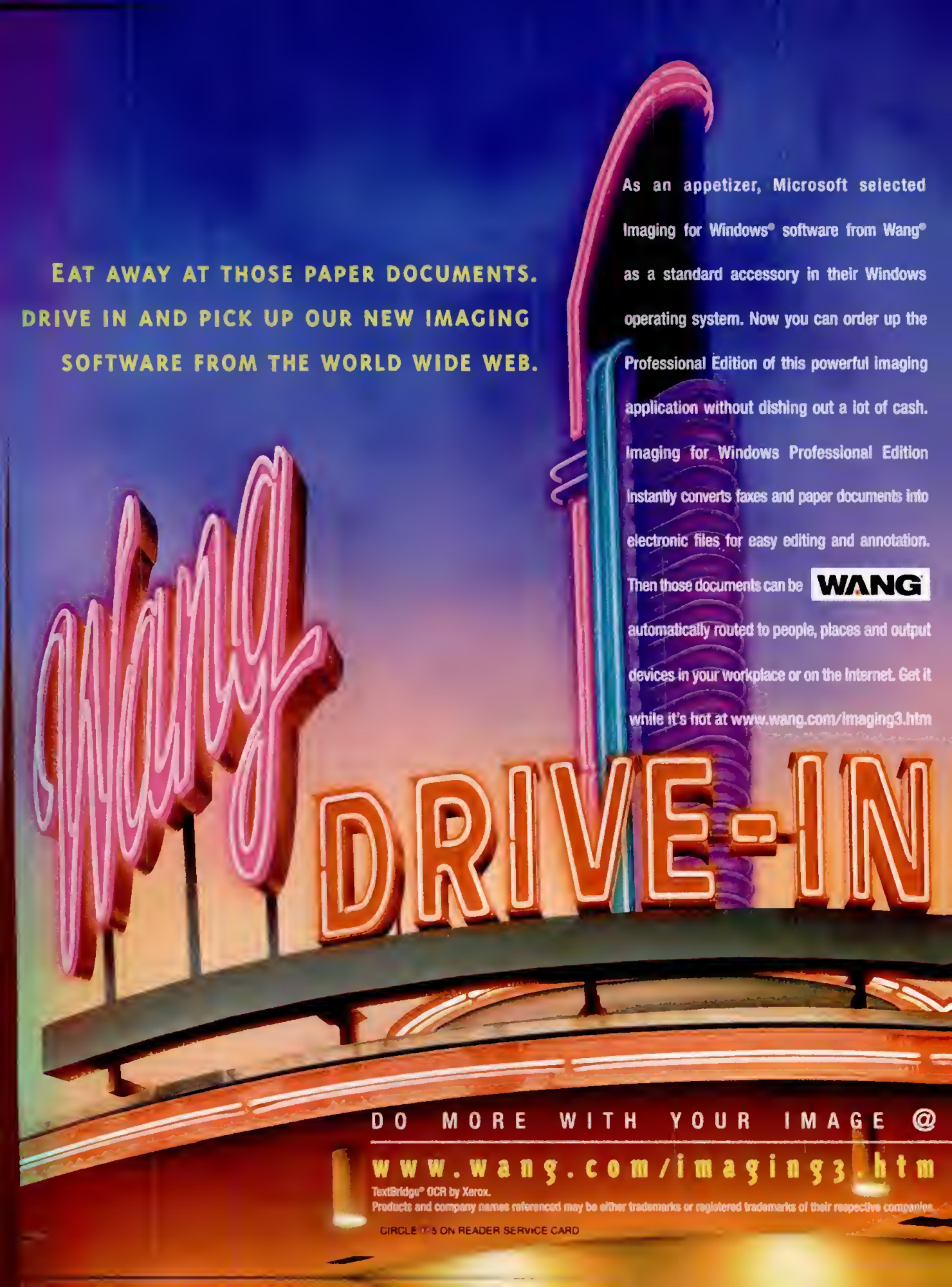
Coming soon to a Web site near you: Adaptive Prediction technology from Net Perceptions Inc. and its powerful **Group-Lens Toolkit 1.0** ($47,500 per server). It is available only for Sun Solaris, but it can run on any Web server. Based on innovative collaborative-filtering research, Group Lens Toolkit can bring this predictive technology to any Web site.

Collaborative filtering predicts what products or items you might like based on the preferences of similar users. This process requires you to fill out preference forms. Group-Lens Toolkit also includes tools to allow Web sites to guess your preferences implicitly. The length of time you spend looking at a page can measure what you like. Suppose you're shopping at a virtual store and place items in a shopping basket. Even if you don't buy all the items, you've still expressed a choice. Group-Lens Toolkit includes tools to record these user preferences and factor them into the collaborative-filtering process. The Toolkit can also gauge how accurately a site has been measuring user preferences by applying both explicit and implicit rating styles.

These tools take advantage of some cutting edge research in the field of collaborative filtering based on signal-detection theory research. This allows Webmasters to strike a balance between explicit and implicit styles so that a site can be convenient for users and still accurately guess what they want.

Amazon.com (an online bookstore), StarWave (a content provider for entertainment), and Sabre (a provider of travel-industry services) have licensed this technology. (We previewed a demo site, which showed the Toolkit at work.)

Adaptive Prediction technology clearly points toward a future where you can train a Web site to give you personalized content based on your actions.


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FUTURE DISTRIBUTED COMPUTING

Bandwidth and standards will make good on years of networking promises.

By Larry Seltzer



For many of us, automated teller machines (ATMs) are a way of life. It's hard to remember that you used to have to go to a centrally located bank to get cash or do other banking. Now you can use one of these little machines almost anywhere, anytime. You don't think about the system behind it the same way you don't think about the systems behind PCs and networks.

ATMs are a good example of *distributed computing* (in which different parts of an operation run on widely dispersed computers connected over a network). The computer in the ATM you happen to be using, the ATM's home bank, the ATM network, your personal bank, and (potentially) other systems are all involved in the transactions you engage in—and they're all connected.

Most distributed applications (such as those for ATMs) have been proprietary. Only recently have such applications come within reach of conventional PCs and their operating systems. But widespread networking (ever hear of the Internet?) makes it likely that distributed computing will become a standard practice among PCs—especially servers—over the next 15 years. We'll be able to conduct more and more personal and professional business from more convenient locations—even our homes.

From the development end, it may become practical and easy to write distributed programs for PCs. In addition, widespread distributed computing should allow for more efficient use of computers on a network by moving tasks to systems with available bandwidth.

Distributed computing requires several pieces to succeed: The computers need to communicate with each other, traffic rules need to be enforced (that is, determining what goes first, what goes second, what happens if something fails, and so on), and the computers need to find each other. In recent years, we've seen open standards emerge for developing powerful distributed applications. Among these are standards for distributed objects, transaction processing, and directory services.

DISTRIBUTED OBJECTS

Above the basic network transport layer, the most fundamental layer for distributed processing is the one in which programs call each other. For some years now, we've had standards for these *remote procedure calls* (RPCs), especially the Open Group's Distributed Computing Environment DCE RPC, which permits remote calls in a general-purpose, cross-platform manner. Many distributed systems do not support or use them.

INSIDE

OBJECT-ORIENTED COMPUTING
TRANSACTION PROCESSES
DIRECTORY SERVICES

Object orientation, which attempts to simplify things by enveloping computing complexities into functional objects, is better than RPCs for distributing applications. And the more complex the service being distributed, the better it is to use object technology. Several important standards already exist in this area, and they interoperate to a certain extent. Their architectures are converging sufficiently, so increasingly powerful interoperability is likely in the future.

TRANSACTION PROCESSING

Distributed computing requires the operations on various computers to be dependent on one another. Consider a credit card transaction: If the debit from your account fails on your credit card issuer's computer, it would be a bad idea to credit the store's computer. Either the whole thing succeeds or the whole thing fails.

Transaction processing has its origins in database technology, where it is used for sets of dependent operations. A good transaction-processing system also provides a mechanism for simplifying the development of complex programs.

DIRECTORY SERVICES

Directory services come into play when you need to find all of those network devices out there. Directory services standardize the way we organize such devices, especially in the context of security.

Security is a big issue when you're allowing users to access devices across a network. Administrators need a measure of control and audit authority over access to those devices, and directory services are designed to associate security to devices (such as users or servers) on a network.

THE FUTURE

In 15 years, many of the cost and capability constraints on today's computing will disappear. Consider that 15 years ago the typical PC had an 8088 processor and maybe 256K of RAM. Networking was virtually unheard of. If advances in power over the next 15 years are at least as great, we'll all be running powerful PCs with hundreds of

Distributed Platforms



Remote File System
Essentially a remote file system, the Web is an example of a simple but highly effective distributed platform. Clients can request server-based objects through HTTP. These objects download and then execute on the client. Typical objects include HTML pages, graphics, script, and Java code. Extensions to the system allow streams of multimedia data.



Distributed Objects
Distributed object models such as DCOM and CORBA/IIOP are the backbone for today's complex distributed applications. Program components can communicate with other components remotely through standardized interfaces. The operating system and the network plumbing that connects them are hidden from the programmer and end user.



Moving Objects
In the future, distributed objects may actually move themselves around over the Internet on your behalf, carrying their data and state with them. This technology would make possible new classes of applications that would actively search for data—which could be anything from an arbitrage opportunity to a buyer and seller for a vintage car.

megabytes or more of RAM. Greater power facilitates distributed computing because it increases the power of servers to handle large numbers of remote users.

We can also anticipate vast improvements in network bandwidth. In networks, fiber-optic cable will be the common carrier of data, bringing with it multigigabit data rates. The speed and capacity of the network infrastructure hardware will improve as well. We may even break the monopolies on the local loop for phone service by then, and numerous high-speed data options will be available for homes.

Such a world would be ideal for distributed computing. You'll be able to move large amounts of code and data across the network for even ordinary tasks. This would facilitate load balancing, since programs could move themselves to the most available computer.

In a directory service of the future, users might view objects situated across the entire Internet and customize the view to their needs. In a truly distributed world, directory services will run the appropriate device, whether it's local or on another system. You can think of this as location independence.

We can also expect more reliability from the whole infrastructure of the Internet and private networks. When both are reliable (and when all the security and performance enhancements are made), major companies will shut down their private wide-area networks and move their traffic onto the Internet, buying connections on the network-bandwidth commodity market. When vendors and customers finally have enough confidence in such a public network, we will find numerous Holy Grails of computing, such as public, open EDI networks.

EMERGING DISTRIBUTED COMPUTING

PC SIZE, MAINFRAME POWER

Despite competing approaches, the latest trends in distributed objects and naming services are empowering PC networks. **By Larry Seltzer**

IBM, Microsoft, and Netscape have staked much of their Internet futures on distributed object models. Distributed objects are not the ones programmers deal with regularly. Objects in the Distributed Common Object Model (DCOM) or the Object Management Architecture (OMA) exist at the system level. Objects elsewhere in the system and elsewhere on the network can interact with them as objects. They may be able to query their capabilities or inherit them for their own use. System objects such as OMA and DCOM can also be written in almost any language.

DISTRIBUTED COMMON OBJECT MODEL

DCOM is the distributed version of COM, the object model behind OLE and Active X. This object model is implemented in Windows and is coming for the Macintosh and Unix.

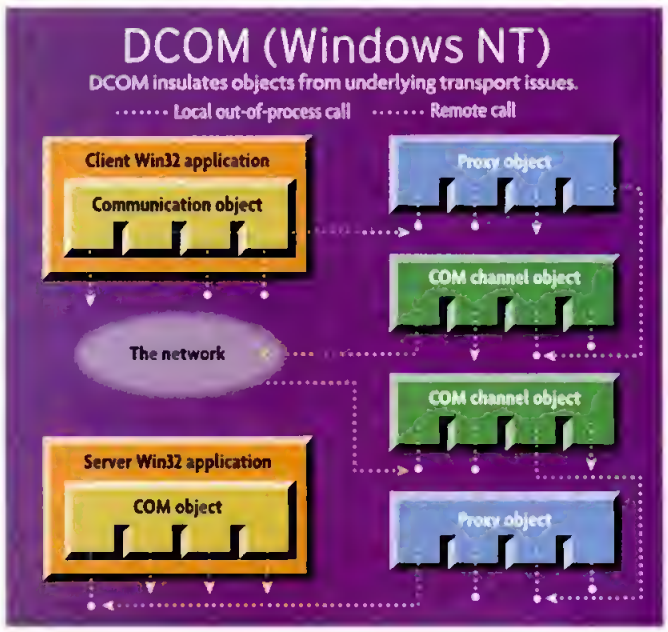
Although COM benefits from strong development tools, writing a good program with COM and DCOM can still be difficult. A high-performance server object, for example, needs to be cognizant of arcane threading models. Microsoft's Transaction Server offers a solution here.

The programming model for DCOM is identical to that of COM, but it can take some work to port COM programs to DCOM. DCOM has an advantage over OMA and CORBA (Common Object Request Broker Architecture) in the area of interoperability, because it is a more rigidly defined standard. Because you know that a COM object will work on an implementation of COM, an open market already exists for COM objects. This is unlikely to happen with CORBA objects, because they tend to be ORB-specific. DCOM also works over connectionless protocols (such as UDP and IPX). OMA does not use these protocols.

OBJECT MANAGEMENT ARCHITECTURE

The Object Management Group's OMA is often called CORBA, even though CORBA is only part of the larger OMA. The OMA encompasses the Internet Interoperability Protocol (IIOP) and other related services.

Vendors implement CORBA on many platforms, including IBM's SOMobjects (one is coming from Netscape). Most of CORBA's architecture is like DCOM's, but CORBA adds a new layer: the Interface Definition Language (IDL). The IDL defines the interface of the object separate from its implementation. Developers compile the IDL into interface code, which connects to the object broker and implementation code on both systems. This code can be written in almost any language, and the data type mappings between the implementation code and IDL are part of the OMA standard.



Only with the release of IIOP have different CORBA object brokers had a common wire-level protocol. Even with IIOP, proprietary extensions are a necessity of CORBA development, and they make it difficult to port objects or have them interoperate with those on other platforms. Despite these problems, OMA is a rich architecture with many powerful vendors behind it.

DISTRIBUTED JAVA PROGRAMMING

Two services are available for writing distributed applications in Java. Version 1.1 of Java Development Kit (likely shipping by the time you read this) features both a CORBA-compliant IDL facility and a native Java remote method invocation (RMI) facility. Most Java programmers will access these facilities indirectly through JavaBeans, a component software specification.

Java IDL is an IDL compiler that allows you to map Java objects to CORBA object brokers. Thus you can interoperate with objects written in other languages and possibly running on other systems. A developer must follow a protocol for naming CORBA objects inside Java and vice-versa. This makes it easier to integrate a Java system with legacy code, which likely isn't written in Java. Performance should improve as well.

RMI works only between Java programs running on different systems. RMI usage isn't seamless: You must declare remote classes explicitly and perform other rituals to ensure implementation. By default, RMI works directly on Java's own sockets interface. Although this will let you implement your system on any Java system, it keeps communication outside of any other security and distribution facilities you have. But RMI does let you take advantage of Java's security features, including the sandbox, multithreading, and garbage collection. Moving RMI programs around to any system using a Java virtual machine (VM) should be easy.

TRANSACTION PROCESSES

Consider a credit card purchase: The debit from your account and the credit given to the vendor is a good example of a transaction. If your purchase isn't ap-

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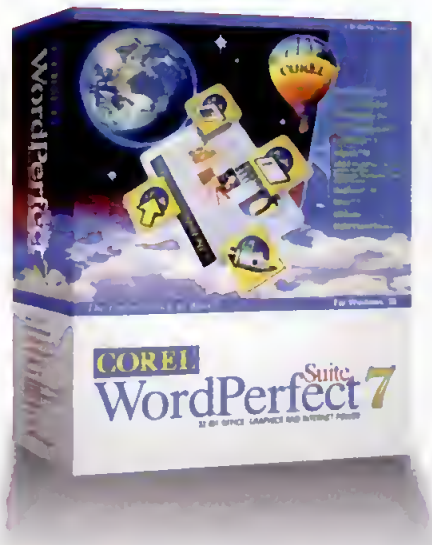
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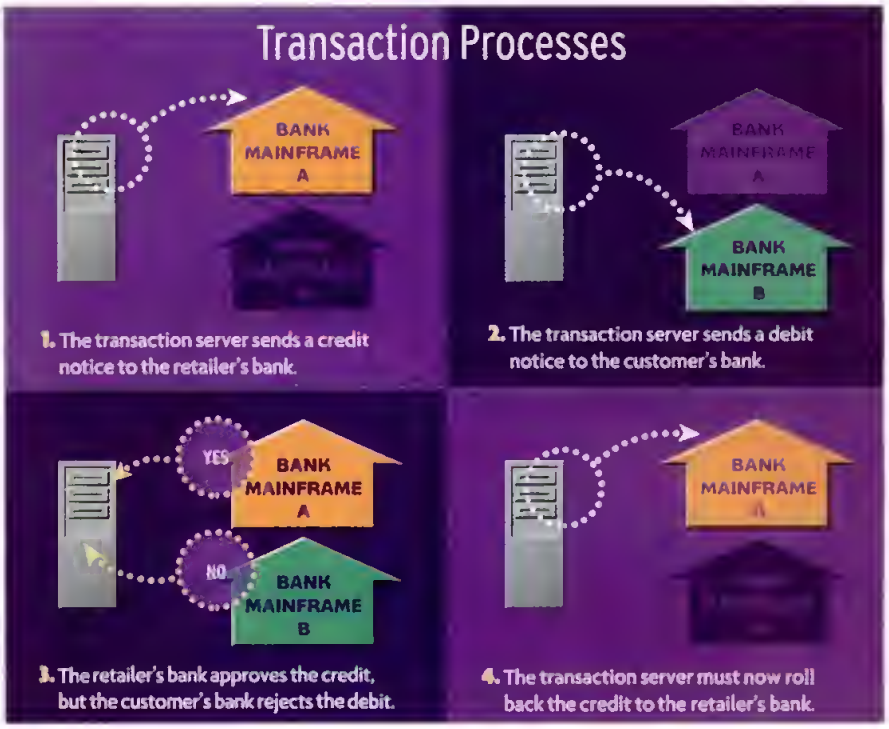
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proved, the bank won't credit the retailer's account. A transaction is a series of operations that a programmer designates as a logical group. If any of them fails, then you don't want any of them to execute.

Server and host processes comply with standards for letting such systems work correctly, including the X/Open XA architecture and part of IBM's LU 6.2 specification. A programmer begins a transaction, designates the operations, and (if no servers complain) performs a *commit*. If a problem arises with any operation, the program performs a *rollback*. This is called a *two-phase commit*, and a transaction-processing (TP) system manages it. In our credit card example, if either your debit or the store's credit fails, the TP system should roll back the other.

Distributed systems represent fragile operations. While well-designed distributed operations rarely involve more than three different systems, the number of potential points of failure is much greater than on a single system. Also consider that distributed objects are client and server processes. Such factors make it complicated to design a high-performance server object.

For many years now, mission-critical enterprise mainframe systems have employed expensive proprietary TP monitors to govern such operations. With high-performance server operating systems, new standards in network communications, better development tools, and the ability to distribute object models on which to build TP systems, mainstream PCs can now handle what was once practical only on mainframes.



IBM TRANSACTION SERVER

The mother of all online transaction processing (OLTP) systems is IBM's Customer Information Control System (CICS). Although CICS has been run mainly on mainframes, IBM has ported it to Windows NT, OS/2, and AIX as part of the company's Transaction Server. CICS was written back in the late 1960s to run in environments so slow and so resource-constrained that they seem impossible these days. (Imagine mainframes with 128K of RAM.) CICS earned a reputation on mainframes for the highest reliability and scalability.

On the newer platforms, such as Windows NT, CICS is built on top of the Encina transaction monitor. The two, along with client software, form IBM's Transaction Server. Encina removes details of the file and communications subsystems from CICS, making both CICS and applications easier to move between platforms. It also emulates some mainframe services, such as the VSAM file system, and connects to databases such as MS SQL Server and IBM's Database Server. Encina is built on top of OSF's DCE Services, including RPC and DCE security, which it can use in addition to conventional CICS security. Lastly, Encina can tie any XA-compliant process into the transaction system.

Application programmers can write to CICS APIs, usually writing in COBOL using the standard CICS APIs. IBM's Transaction Server does not provide a full implementation of those APIs, but the missing parts are esoteric.

There are several ways to program CICS under Transaction Server. ECI (Extended Call Interface) is a standard call-level interface for high-level languages. And although EPI (External Presentation Interface) is geared toward terminal communications, applications can use this interface for "screen-scraping" the I/O to present it in other media. For example, CICS Internet Gateway uses EPI, turning 3270 applications into HTML programs.

CICS Gateway for Java exposes Java classes for programming CICS. IBM has high hopes for it and CICS Internet Gateway in terms of exposing enterprise data to network computers and other Internet-connected clients. IBM also has CICS Gateway for Lotus Notes, which exposes CICS data as a Notes database and lets programmers manipulate it with Notes macros and LotusScript.

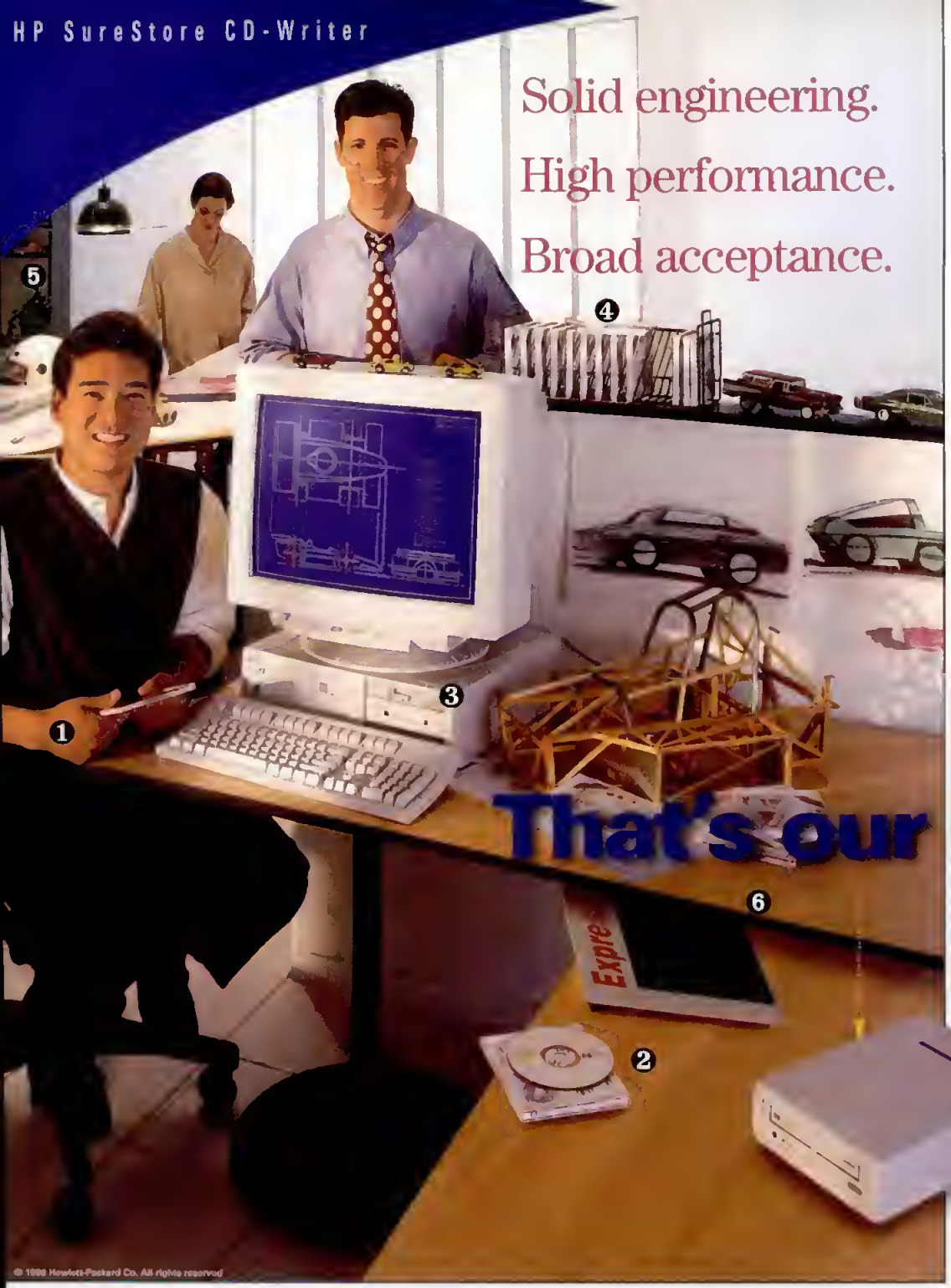
MICROSOFT TRANSACTION SERVER

Microsoft Transaction Server runs on Windows NT Server 4.0 and uses ActiveX as its client programming model. Very little is needed to create a transaction; the process can be accomplished using drag-and-drop through the user interface rather than an API-based task. A few COM interfaces are provided for API-level programming. Transaction Server talks to XA, LU 6.2, and OLE TX transaction monitors (OLE TX is a Microsoft spec).

Transaction Server makes server-based programming easier. One of the hardest parts about designing a high-performance server application is designing its thread and process model correctly. If you do this badly, the application will not run well. Threading models in a COM-based process are es-

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pecially complicated.

With Transaction Server, you just design simple operations as ActiveX components in single-user DLLs, and the server handles all the messy details of thread and resource management. Because Transaction Server components are ActiveX components, which define specific interfaces, Transaction Server can call the correct code to commit the work or roll it back.

DIRECTORY SERVICES

So you've got objects and you've got a network. How do your programs find the objects with which they need to communicate? By using a directory service—the last step necessary in building a distributed platform.

Current directories consist mainly of a fairly simple hierarchical database. Network managers use this database to store information about users, network resources, arbitrary objects, and security. In the long term, the directory service will be the glue that binds the objects in the directory to their different roles. Here's a look at several important directory services now on the market. They've come a long way, but they also have a long way to go.

Domain Name Service (DNS) is the naming service for the Internet. It's not really a directory service, but it performs many of the functions of one. DNS is slow and highly static: You can look up names, and the infrastructure gradually replicates these names throughout the network. The directory basically supports only the relationships of names (*www.pcmag.com*) and IP addresses. Programs then use these to perform actual operations. No structure exists to support security or objects more complex than addresses. This testifies to its weakness as a standard.

Much enthusiasm has been expressed recently over the **Lightweight Directory Access Protocol (LDAP)** as an emerging standard. Indeed, many major vendors (Netscape and Microsoft included) have announced or shipped support for it. But LDAP isn't a rich directory service; its principal strength at present is that it's a least-common-denominator solution.

Names in an LDAP have various attributes, including organizational units and a country code. The directory structure isn't simple, but its complexity tends to be hidden by the application. Its implementations rely on proprietary extensions, which weaken its applicability as a standard. The Internet Engineering Task Force (IETF) is working on future generations of LDAP to make it stronger.

Debuted in NetWare 4.0, **Netware Directory Service (NDS)** is perhaps the most widely used directory service on private networks. Novell has announced plans to port the core features of NDS to other platforms, including many Unix versions and Windows NT.

One of the strengths of NDS is that its directories can be "federated" with other NDS directories while preserving the security of each site. This means that users on different networks can have selected access to each other's resources. Security is still managed by administrators of the individual organizations.

Novell is working on enhancing NDS. At the same time, it's also working with the IETF on future versions of LDAP.

Microsoft has recently announced a next-generation directory service as well as a new COM-based system for generic directory-services programming. The **Windows NT Server Directory Services** supports a variety of naming schemes, including LDAP, X.500, URL, UNC (*\\myserver\\sharename\apps\excel\excel.exe*), and RFC822 (better known as Internet e-mail addresses, such as *johns@company.com*). Microsoft's Directory Services also supports the storage of public key certificates and the explicit storage of private keys based on the MIT Kerboros authentication protocol.

Object Management Architecture (OMA) defines two promising services for retrieving names from a variety of providers using standard Common Object Request Broker Architecture (CORBA) programming. But they are still works in progress and are not yet widely used.

The **Naming Service** associates names with object references, which you can then use to perform operations. The **Trading Service** is a catalog in which servers can advertise names and the properties of those names. The Trading Service supports lookups for objects based on those properties. Like NDS, the Naming service supports the federation of name spaces within an enterprise. □



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FUTURE USER INTERFACES

Voice and handwriting will be common modes of man/machine interaction.

By Les Freed



Many things about PCs have changed since IBM's first model rolled out the door in 1981—with one notable exception. The majority of our computer interaction still takes place through the keyboard and screen, just as it did 15 years ago.

The idea of an "alternate user interface" holds an almost irresistible appeal. Typing is fine for people who are good at it, but many PC users are poor typists. And more than a few business professionals have never embraced a PC because they never learned to type.

Two relatively new technologies may make the keyboard at least optional within a few years—and eventually maybe even obsolete. Voice (or speech) recognition—once a seemingly impossible task for a PC—is now a reality. And handwriting recognition, widely used on hand-held PDAs such as Apple's MessagePad, has made huge strides in the past few years.

INSIDE

VOICE RECOGNITION

HANDWRITING RECOGNITION

SPEECHMAGIC

Both voice and handwriting recognition face the same obstacles on the road to mass acceptance: No two people speak or write in the same way. Voice and handwriting recognition products must analyze the input they receive, compare it with a model, and decide what it is we said or wrote. When you consider the English language's complexity and the variations in pronunciation and handwriting styles, it's a wonder these systems work at all.

TYPING WITH A PEN

Even at its best, the QWERTY keyboard is a less-than-ideal input mechanism. Handwriting recognition systems accept input written with a stylus—usually an inkless plastic or metal penlike device. To enter text, you write with the stylus on the recognition device's surface. This technology is now widely deployed on PDAs, because it permits a smaller, lighter unit; the screen can double as the input receiver.

But handwriting recognition seems more ideal for the PDA world than the desktop: Most of us, even when hunting and pecking, can still type faster than we ean write. Voiee reeognition, on the other hand, is the ideal desktop application; just about all of us can speak faster than we can type.

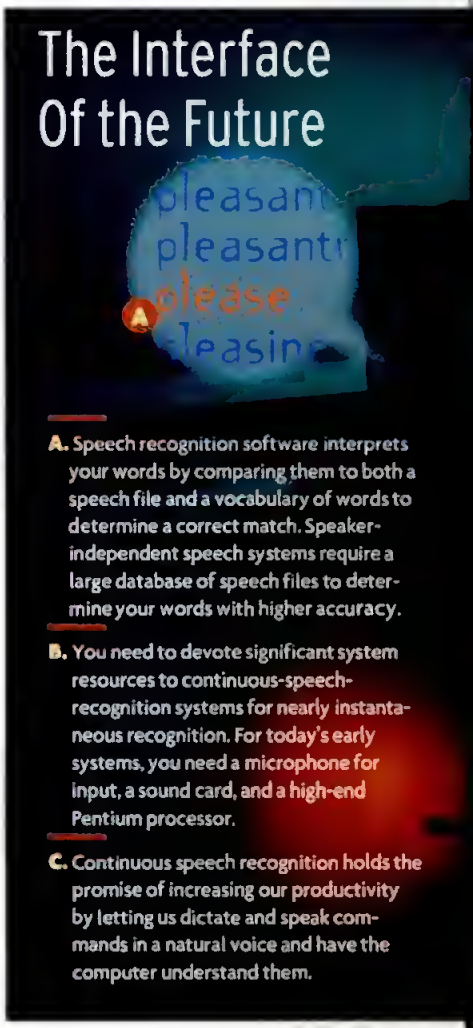
TALKING TO THE COMPUTER

Today, we have discrete speech recognition systems, and they work very well. But they can process only a single word at a time. Continuous-speech systems, which have the potential to change the way we work and significantly expand the number of PC users, are currently being rolled out in vertical markets, such as radiology. This software can handle complex, industry-specific terms (not likely to be confused with others) much better than the simple words we use daily.

What's needed for continuous speech recognition to enter our everyday lives? Karl Sahora, president of Philips Speech Processing USA, believes that the vocabulary needed for general use is around 200,000 words and that the processing power the desktop requires to handle this kind of technology must increase significantly. Currently, Philips' speech recognition engine, running on a high-end Windows NT system, handles about 64,000 active words of specific context.

SPEAKER INDEPENDENCE

Continuous speeeh is only half of voice recognition's Holy Grail. The other half is speaker independence.



A. Speech recognition software interprets your words by comparing them to both a speech file and a vocabulary of words to determine a correct match. Speaker-independent speech systems require a large database of speech files to determine your words with higher accuracy.

B. You need to devote significant system resources to continuous-speech-recognition systems for nearly instantaneous recognition. For today's early systems, you need a microphone for input, a sound card, and a high-end Pentium processor.

C. Continuous speech recognition holds the promise of increasing our productivity by letting us dictate and speak commands in a natural voice and have the computer understand them.

Speaker-independent systems can recognize voice input from anyone at any PC anytime. Right now, systems require an initial training period in order to create a voice file for the speech recognition engine to use as a point of comparison with the speech being entered. Without such a file, the near-100-percent accuracy that Philips and IBM deliver in their vertical systems today could not be achieved.

Speaker-independent systems will require large samples of voice snippets for the computer to build a certain acceptable range for all words. Such samples will let them recognize a user's particular diction, inflection, and voice timbre. Lernout & Hauspie Speech Products (L&H) has created a "linguistic database" to be used as the basis for its recognition engines. The database makes possible innovations such as dictating e-mail to your computer and having it read back to you.

IS IT 2001 YET?

In Stanley Kubrick's 1968 film *2001: A Space Odyssey,* a computer—the HAL9000—played a central role. HAL understood every word he heard, including nuance and subtleties, and he responded in a soft, mellifluous voice.

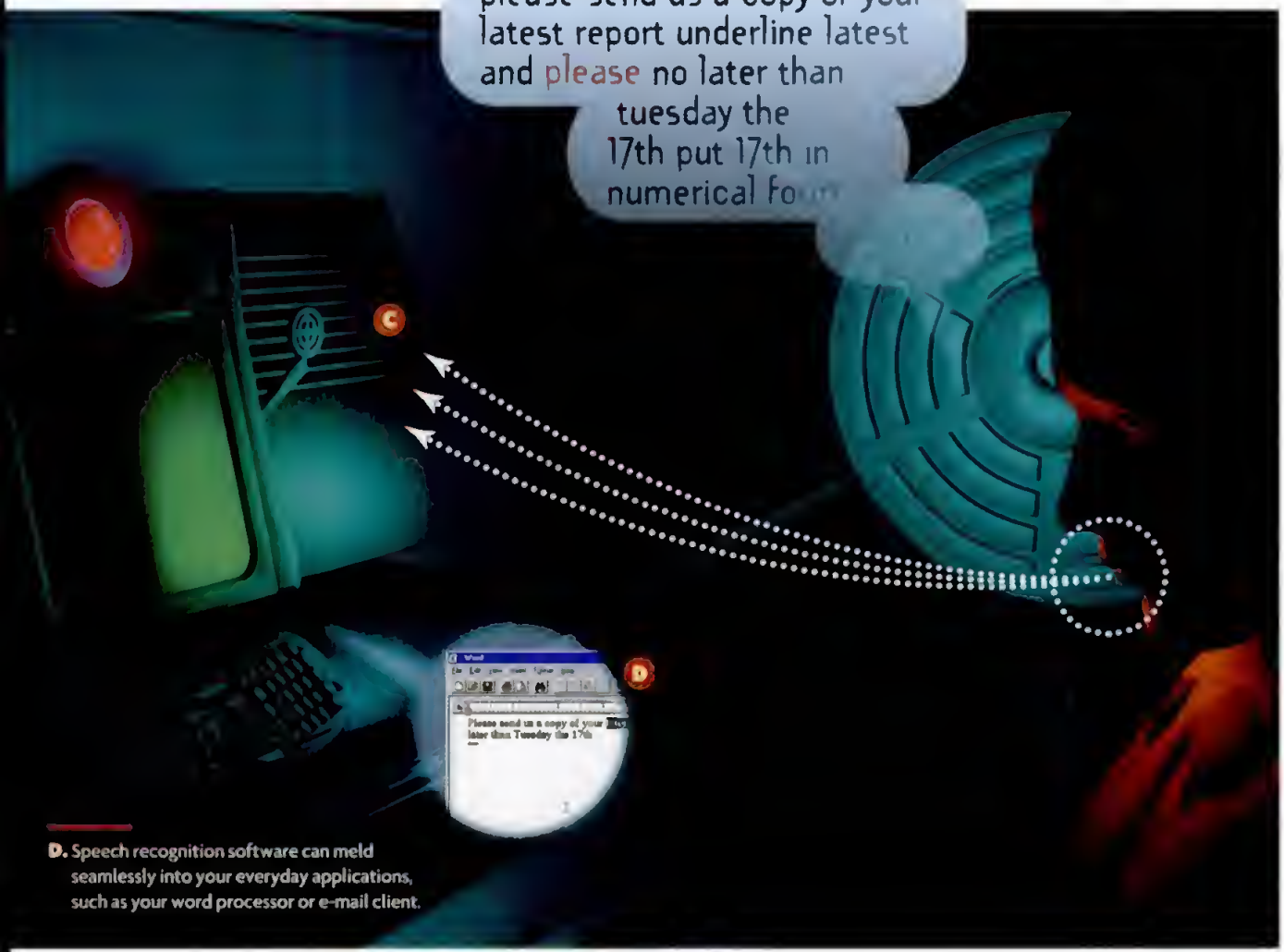
Of course, HAL was a Hollywood prop. To understand whether a HAL-like system is possible soon, we spoke with Dr. Jim Glass, principal research scientist at the Massachusetts Institute of Technology's Spoken Language Systems group. His group has already moved from speech recognition to speech understanding.

The difference between the two technologies is vast. In speech recognition, the computer simply determines how to spell each word it hears in order to display it on-screen. Speech understanding goes the next step; the computer builds a series of connected ideas from the stream of words it hears.

Glass and his colleagues have created a prototype system called Galaxy that responds to natural-language input voice commands to make airline reservations or check the weather. Galaxy doesn't talk back as HAL did, however.

Glass admits that "the speech-recognition folks and the speech-synthesis people don't talk to one another as much as they should," but he notes that each group is beginning to take more notice of the other's work. Glass and his group are also beginning to move away from Unix-based workstations and toward multi-CPU Windows NT systems.

And how soon might we see a HAL-like system? "Galaxy is a long way from HAL," says Glass, "and it operates on a very limited knowledge domain. Then again, 2001 is still four years off, isn't it?"



D. Speech recognition software can meld seamlessly into your everyday applications, such as your word processor or e-mail client.

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EMERGING USER INTERFACES

RECOGNIZING THE FUTURE

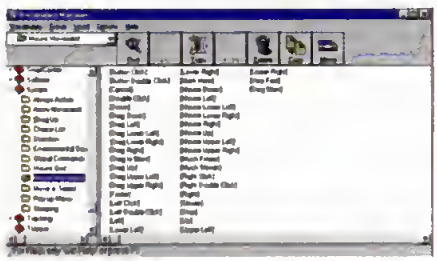
The current crop of speech and handwriting recognition technologies remind us just how close 2001 really is. **By Les Freed**

Although speech and handwriting recognition products have been around for some years, they have been in forms that clearly show these are still emerging technologies. We're still years away from slick desktop systems that will accept input from you in any way you choose (whether by keyboard, speech, or handwriting) and give output back (whether by synthesized voice, screen, or printer).

It's probably our overexposure to the facile voice recognition rampant between humans and computers in science fiction movies and TV shows that preconditions us to expect so much from these products right now. The truth is, the voice recognition products out on the market are pretty good, when you consider the complexities of English itself as well as the many dialectal variations and other distinguishing pronunciations. All the products seem to specialize to some extent—in order to deliver better performance in some areas—yet all are aimed at similar goals.

DICTATION AND CONTROL

A capable, easy-to-use dictation and voice control program for Microsoft Windows 95, Dragon Systems' **DragonDictate for Windows, Version 2.52** ($695 list), performs all its discrete speech recognition tasks admirably. But where DragonDictate really shines is as a voice control program.



DragonDictate provided the best system for mouse positioning, including an extensive command set and a nine-zone grid.

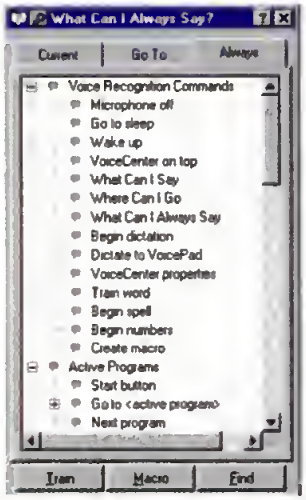
DragonDictate was the only product in our test group to provide easy, accurate mouse positioning. All you have to do is say "mouse up" or "mouse left" and the pointer moves to that spot.

We were also very impressed with Dragon's clever mouse grid system. It provides very accurate mouse positioning, but using this system can be time-consuming. To use it, you say "mouse grid," and a nine-zone grid appears on-screen. You can move the pointer to any of the nine zones by saying the zone number. When you do, a new and smaller grid appears in the selected zone.

New users need to read only 16 simple words, such as *international* and *technology,* for initial training before they start dictating. We obtained very good recognition accuracy after the initial training. DragonDictate fine-tunes your profile as you use the product, learning your pronunciation peculiarities on the fly.

The program's method of recognizing speech can be distracting, however, because it assumes that you're watching the screen as you dictate. As you dictate each word, DragonDictate displays a list of the ten closest matches in its vocabulary, with the most likely match at the top. If DragonDictate misunderstands a word, you can choose the correct word from the list. Or you can spell the correct word, and DragonDictate will learn it. We found this method of simultaneous dictating and editing to be surprisingly reassuring.

DragonDictate maintains two distinct vocabularies. The 30,000-word active vocabulary, which consists of the most commonly used words, resides in RAM; a 120,000-word back-up vocabulary stays on the hard disk.



VoiceType for Windows uses discrete speech recognition that is fast and accurate.

ADDING VOICE TO WINDOWS

IBM was a pioneer in computer voice-recognition, and the company's extensive experience is reflected in these products. Although the two products are vastly different and are aimed at different markets, both use the same speech recognition technology.

VoiceType for Windows ($699 list) adds voice command operation to Windows 95. It also adds voice dictation capabilities to several popular Windows applications, including either of Corel Corp.'s office suites, Lotus SmartSuite, and Microsoft Office. VoiceType comes with a 22,000-word vocabulary, and you can add another 42,000 words of your own.

We found VoiceType's discrete speech recognition to be fast and nearly 100 percent accurate, but voice command operation was a bit awkward, especially compared with DragonDictate's.

VoiceType's initiation process is pretty painless. It installs from a CD-ROM in about 5 minutes, and you can train VoiceType with a brief enrollment session in which sentences flash on-screen and you read them back.

The VoiceType package includes a comfortable headset that has a noise-cancelling microphone. The headset features an on/off switch for the microphone, so you can mute the microphone during a dictation session. This is a welcome, real-world feature.

DOCTORS HAVE ALL THE FUN

Radiologists lead us into the forefront of speech recognition, as IBM has developed a continuous-speech voice-dictation package specifically for them. The company's $4,495 **MedSpeak/Radiology 1.1** is a CPU-intensive client/server system with a 25,000-word vocabulary that runs on Windows NT. Its near–real-time recognition and high accuracy rate during our ad hoc testing bode well for the future.

Dictating medical reports based on findings in X rays and CAT scans occu-

Speech Magic from Philips

Considering its status as a major force in the dictation-equipment business, we guess it's no surprise that Philips Speech Processing's SpeechMagic voice recognition system is modeled after a traditional dictation and transcription system. In traditional dictation, the user will dictate a report, a memo, or a letter into a recording system, and later that recording will be transcribed by a stenographer or a secretary. Philips' SpeechMagic system, unlike IBM's MedSpeak, follows the same model.

To create a document, a user dictates into a PC using Philips' proprietary microphone, which resembles a standard dictation microphone. The SpeechNote voice-file-creation software can reside on a multitude of desktops, and the SpeechMagic voice recognition engine can run on just one or a few systems to offer an enterprise solution.



The SpeechPad delivers an on-the-go solution for continuous speech recognition.

A transcription operator can then process the collected digital voice files through the SpeechMagic recognition software and thereafter serve more as an editor than a secretary.

When the product was demonstrated in our New York offices, SpeechMagic recognized about 99 percent of the words in a sample radiology report. The one word it missed was *cauliflower*, which wasn't in its vocabulary. (SpeechMagic contains a 64,000-word vocabulary stored in RAM, with an additional 44,000 words stored on the hard disk.) Philips uses a proprietary speech recognition accelerator board to achieve near–real-time recognition of all recorded speech files.

Philips sells the SpeechMagic system through a network of value-added resellers and independent software vendors. These VARs and ISVs tailor the system for a specific discipline, such as litigation or radiology.

Philips also showed us a preview of SpeechPad, a hand-held digital voice recorder that's the exact shape and size of a microcassette dictation recorder. Users can record dictation just as they would on a microcassette recorder. The medium, however, is a PCMCIA card. Users can then download the digitized voice data into a PC for later recognition and transcription—and even transfer the files via e-mail when they are working on the road.

pies a significant portion of a radiologist's day. MedSpeak lets doctors make these reports more timely and accurate, because the doctors can see written reports on-screen as they are being dictated.

To test the product, we read some sample radiology reports, provided by a doctor. The results were startling. Even without training the system to recognize a particular voice, MedSpeak provided a transcription that was nearly 100 percent accurate. The words appeared on-screen a fraction of a second after they were spoken, even when we intentionally ran the words together. MedSpeak even understood our purely phonetic pronunciation of some unfamiliar medical terms.

Although the language used in these reports is foreign to most of us, it consists of a relatively small vocabulary of medical terms and some simple English words.

MedSpeak is a Windows NT–based client/server system that consists of three components. The server application uses IBM's DB2 database engine to maintain a database of stored reports. The client application performs the actual voice recognition and transcription, and an optional order-entry application allows a medical secretary or other clerical person to enter reports manually into the report database. One server can manage multiple dictation clients. Our version of MedSpeak included a broadcast-quality Sennheiser microphone; for $100 less, you can get an AKG headset instead.

Real-time recognition requires significant computing horsepower. For this reason, IBM recommends using a 200-MHz Pentium Pro to run MedSpeak, although we were able to achieve nearly 100 percent accuracy running MedSpeak on a 200-MHz Pentium.

According to IBM, the recognition technology in MedSpeak can be adapted to any profession that uses a fairly limited vocabulary, including other medical and legal specialties, and will ultimately be used for consumer voice products.

SPEAKER INDEPENDENCE

One of the goals of speech recognition is speaker independence, and **Kurzweil Voice for Windows Release 2.5, Personal Edition** ($295 list) and **Professional Edition** ($595 list), deliver on this front. Although you can use Kurzweil's discrete speech products without any training, they will work much better for you when you devote the time it takes to train the system.

The main difference between the personal and professional versions is vocabulary size: The personal edition has a 30,000-word vocabulary, while the professional edition contains 60,000 words.

Both products are speaker independent, so you can begin using them without having to sit through a lengthy voice training process. Kurzweil claims an "out-of-the-box" accuracy of 90 percent or better, but the programs misunderstood many common words until we went through the enrollment process.

That tedious 45-minute process ultimately proved worthwhile, as accuracy improved to nearly 100 percent thereafter. The programs support continuous number recognition, and we found the voice recognition to be nearly instantaneous, requiring only the briefest pauses between words.

The user interface is simple and unobtrusive. Like DragonDictate, the Kurzweil Voice products each show a list of words as you speak, with the closest match at the top and four alternative choices below. If the programs misunderstand a word, you can choose another from the word list, or you can spell it out and the products will remember it.

The products don't have separate command and dictation modes and don't re-

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quire any special macro files or any other drivers to work with most application programs. We tried them with Microsoft Excel 7, Internet Explorer 3.0, and Word 7 simply by using spoken commands. If you need to enter a word or phrase that's unpronounceable, such as a URL, you simply spell out the text using the military phonetic alphabet ("alpha," "bravo," "Charlie," and so on).

The primary shortcoming was the handling of mouse movement. We found the mouse difficult to control, especially compared with our experience using DragonDictate's mouse grid system. Like the other products in our roundup, the Kurzweil Voice packages each require a Pentium PC with a sound card. Included in both is a microphone/headset.

HANDWRITING HAS ITS DAY

Remember how your fourth-grade teacher used to harp on you to make your letters just so? Maybe she knew you'd need to use a handwriting recognition system some day. Encouragingly, considering the recent past, handwriting recognition today is dead-on accurate. Here's a peek at the technology as applied in three PDA and one desktop (or laptop) system.

Of the three hand-held PC handwriting products we tested, two—the HP OmniGo 120 Organizer Plus and U.S. Robotics' Pilot 5000—use Graffiti, a modified alphabet designed just for handwriting recognition systems. Graffiti provides very accurate recognition on minimal CPU horsepower. To do so, it requires you to learn a modified alphabet, so that it can easily interpret your input rather than learning your handwriting. You enter the letter A as an upside-down V, the letter F as a backward 7. Because Graffiti characters are similar to familiar letters, though, the alphabet takes only about 15 minutes to learn.

To improve recognition accuracy, Graffiti uses separate alphabetic and numeric entry modes, which you switch between easily. This allows Graffiti to assign two meanings to the same character: The 7 is a T in alpha mode and 7 in numeric mode.

The **Pilot 5000** ($299 list) was the smallest, lightest product we saw. It has a relatively small screen—2.5 by 2.5 inches—but it's something you grow to accept for the convenience. It may be trouble for some users in poor lighting conditions.

The **HP OmniGo 120 Organizer Plus** ($400 street) is nearly twice the size of the Pilot, but its screen is about the same. The screen is not backlit, but the OmniGo uses holographic technology from Polaroid, which results in a highly reflective background that makes the screen appear to be backlit under brightly lit conditions. The screen doubles as a touch pad, and you can navigate through the OmniGo's menu system using either the stylus or the keyboard.



Four products drive handwriting recognition forward (from left): CIC's Handwriter Manta, the HP OmniGo 120 Organizer Plus, U.S. Robotics' Pilot 5000, and Apple's MessagePad 2000. Insets: A handwritten note on the MessagePad (above) and MessagePad's interpretation. Not bad.

ANOTHER PLAYER MATURES

Apple Computer's **MessagePad 2000** (to be released about the time you read this; it is expected to sell for under $1,000) represents a big step forward from the early problems the original MessagePad suffered.

Handwriting recognition is the MessagePad's star attraction. We gave the MessagePad to half a dozen people (including two doctors notorious for their awful handwriting) and asked them to write on-screen. Every time, the MessagePad deciphered each person's handwriting with nearly 100-percent accuracy.

The MessagePad is larger than the other PDAs discussed here, but its screen (at 3.5 by 5 inches) justifies the size.

DESKTOP HANDWRITING

Though much of the buzz surrounding handwriting-recognition and pen-input devices has focused on PDAs, the desktop and laptop crowd has not been neglected entirely. CIC's **Handwriter Manta** ($269 list) is a pen-input device that effectively translates handwriting into typed text. It takes some getting used to, but it works with any Windows-based laptop or desktop PC.

The Handwriter uses a battery-powered radio-frequency pen. The writing surface detects the radio signal to determine the pen's position. Because the Handwriter includes Microsoft's Pen Windows Extensions, the pen can serve double duty as both a pointing device and a stylus. And because the Handwriter knows exactly where the pen is, it can position the cursor with extreme accuracy. The pen position is absolute: If you pick up the pen and move it, say, to the lower-left-hand corner of the tablet, the pointer will jump to the Windows 95 Start button.

The Handwriter's recognition software is easy to install and requires no special training. To use the recognition, you start your application (we used Microsoft Word 7.0) and use the pen to write on the tablet. As you write, your writing appears on the screen in red "ink." As you form each word, the ink disappears, and the recognized text appears in your document.

Unlike PDA-based handwriting systems, the Handwriter does not offer visual feedback from the tablet itself, so you must learn to write while looking at the screen. This takes some practice, but we were writing in a normal fashion in half an hour. The keyboard and mouse remain active, so you can switch among your input devices. □

FUTURE BUSINESS NETWORKING

Today's technologies and tomorrow's economies will expand network options.

By Frank J. Derfler, Jr.



Let's step a decade down the road and peek into the windows of a business office. The cubicles look familiar to fans of Scott Adams's "Dilbert," but the communications links—and, we hope, the productivity—are better than Adams's characters enjoy. The personal digital assistants are smaller and smarter, and the separations between telephone and data systems are gone. Most important, the physical walls of the corporation are less solid and confining.

In the 1990s, the 80/20 rule was a major principle of corporate communications planning. That rule said that 80 percent of corporate voice and data traffic stayed inside the organization and only 20 percent went outside. In the first decade of the twenty-first century, the rule is much more like 50/50. The line between communications inside and outside the corporation is smudged and dotted, and the 80/20 rule is a fossil. Wide area network (WAN) connections are as important to the corporation as local area network (LAN) connections. The extension of corporate connectivity out across a WAN was the end of the third major evolutionary phase of corporate networking. As our time line, "The Evolution of the Network," illustrates, the first two phases focused on getting connected and on enhancing performance. The next two phases focus on providing service with the qualities needed for specific applications, such as video and sound, and on reaching a balance between economy and flexibility.

In the early twenty-first century, the changes in corporate connectivity will be more in quality than in type. You won't see many physical differences, except for an increase in the number of people working from home and in satellite offices. People working outside the office will be tightly connected and more effective, but there won't be a wholesale change in the corporate information infrastructure. Investments in technologies like multimode fiber and switching are safe in the 1990s, because they will have paid long-term dividends.

In 1997, we see that while the rules of corporate culture evolve gradually, it's more difficult to bend the laws of physics. There is a big difference in throughput, cost, and technology between the circuits carrying local area networks and those in wide area networks. LANs extend out to about a mile and provide throughput on the order of 10 to 100 megabits per second (Mbps) at low costs. Short distances keep high throughput at a low cost. Today's local networks typically don't suffer from a shortage of throughput, but the wide area connections are crimped by the laws of both physics and economics. Wide area links today typically have a throughput of 1.5 Mbps and cost several thousand dollars per month.

But if corporate culture calls for more WAN capacity, then in a free economy ideas and competition will follow the need. The options for fast wide area connections will multiply over the next decade as the costs drop. Similarly, a cocktail of LAN technologies will carry the load for new multicast and multimedia applications. Technology can meet the needs in both local and wide area network segments, but the wide area options will be a confusing, regional, and changing mix of technology and politics. The LAN/campus picture will have a lot more bandwidth, with just a little more cost.

Let's take an overview of the technologies that will make a difference in the next decade, and then look at the efforts of specific vendors and how they translate into products.

- **ISDN.** The three killer applications that were supposed to propel ISDN were videoconferencing, remote access, and Internet access. Videoconferencing has grown more slowly than expected, and ISDN's value for remote access and Internet access is threatened by the potential of 56-Kbps modems. (For more on ISDN, see "Home Connectivity" in this issue.) A decade down the road, corporate customers will use very little ISDN, because of the benefits and aggressive pricing of virtual-private-network frame-relay services offered by many competing carriers.
- **56-Kbps modems.** One of the first nails in the coffin of ISDN might be the 56-Kbps modem. While ISDN offers more than twice the throughput, 56-Kbps modems are fast enough for individual Internet access and business remote-access applications, and they don't have the monthly and per-minute charges of ISDN. Standards for these modems won't appear until 1998, but unlike with ISDN, installation should happen practically overnight. (See "Home Connectivity" for a more detailed examination of 56-Kbps modems.) The use of 56-Kbps modems in business, within the limits of their coverage, will offer fast and economical work-from-home service.

INSIDE

THE ILLUSTRATED NETWORK
PLANNING FOR THE DECADE
NEXT-GENERATION ETHERNET

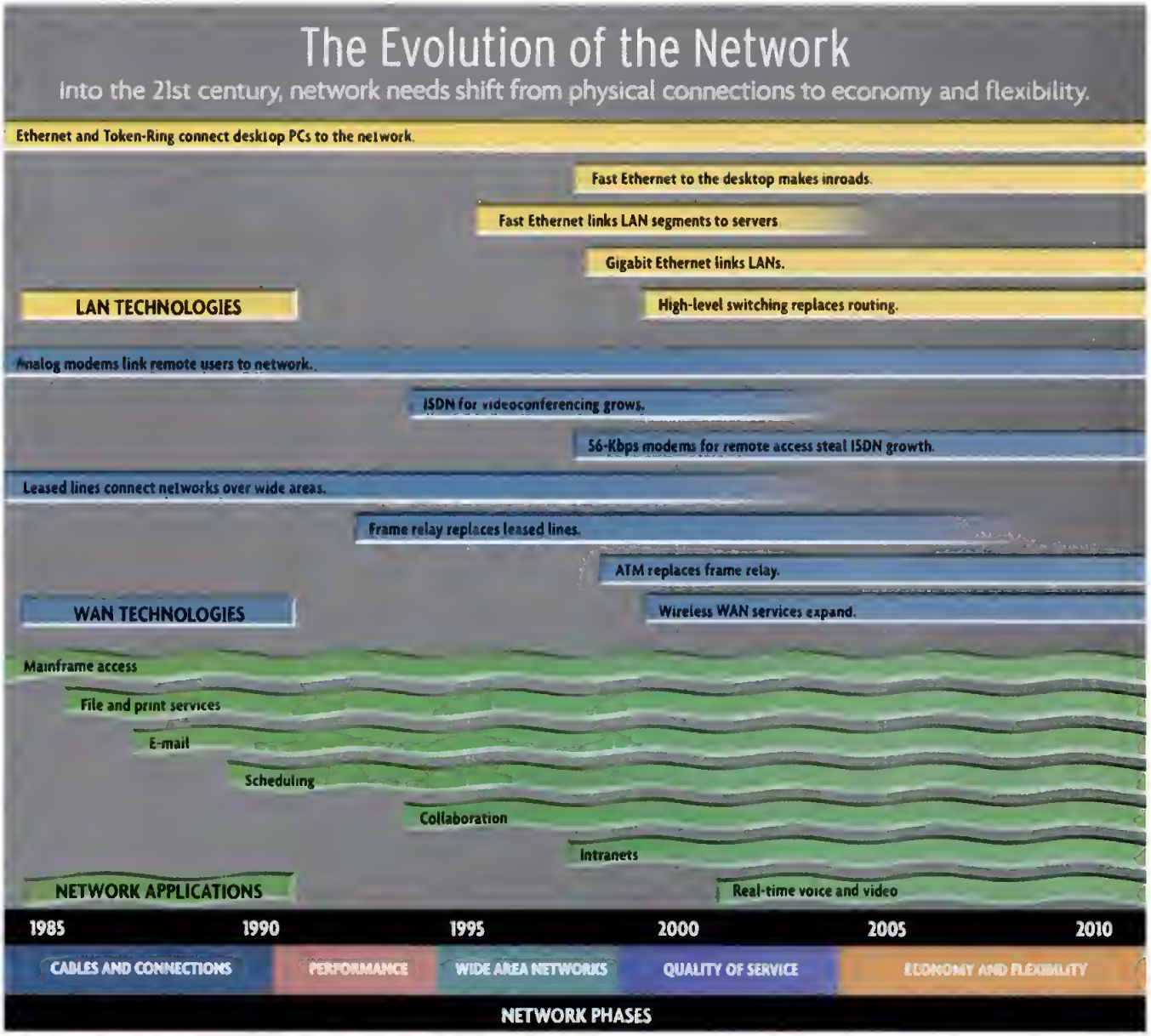
• **Frame relay.** It's been around for many years, but frame relay is just reaching a popularity peak that will last until it is gradually and invisibly replaced by asynchronous transfer mode (ATM) networks after the turn of the century. Frame relay is a WAN digital service that puts data into packets, then sends those packets through a series of interconnected switches to their destinations. It offers flexibility, reliability, and economy.

Large institutions and governments maintain their own frame-relay networks, but most organizations subscribe to frame-relay services from a local or long-distance telephone company or from a specialized data carrier, such as CompuServe Network Services or IBM Global Network. You can vary the type of service by location, and everything from 56 Kbps to more than 155 Mbps is available. The carriers like frame relay because (unlike leased lines) its switched architecture uses their circuits efficiently, so they price it at a flat rate well below that of leased lines and below comparable ISDN connections.

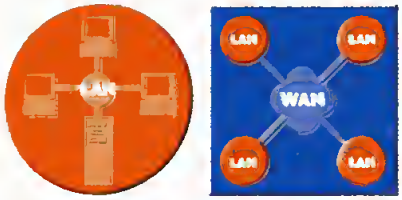
The biggest change that businesses will see in their WANs in the next five to ten years will be virtual frame-relay networks replacing leased lines and ISDN connections. All types and aggregations of telephone, cable, power, and other service companies will offer metropolitan-area frame-relay network services in various configurations and at increasingly competitive prices. Frame-relay providers will compete with Internet service providers.

• **ATM.** It's taken a long time for asynchronous transfer mode to find its niche. While frame relay is great for data, its relatively large packets can be delayed during transmission across the network, so digital video and audio transmissions over frame relay are jerky and full of holes. ATM uses much smaller packages called *cells* and provides for better ways to ensure their timely delivery—a feature called *quality of service*, or QOS.

At first ATM was touted as a way to link local and wide area networks seamlessly, but any demand for ATM to the



The Illustrated Network



Networking terms cover so much territory that they can quickly confuse those unfamiliar with the jargon. To help you get a sense of where these technologies and products fit into your network, we've designed a basic field guide that indicates whether a term applies to ● a LAN (local area network) or ■ a WAN (wide area network). There's no strict definition for either of these categories, but you can think of a LAN as all the PCs, servers, and devices that connect them at a single geographical location. WANs link individual networks or users over long distances and can be private or public. The Internet, of course, is the most famous (and most public) WAN.

● **Fast Ethernet** A networking technology that operates like Ethernet, but at 100 Mbps instead of 10 Mbps. Fast Ethernet is used to provide high-speed connections to servers and between LAN segments. Fast Ethernet can also connect PCs on a network, but many network backbones today would be unable to handle such high-bandwidth connections from every desktop.

● **Gigabit Ethernet** Designed to operate at 1,000 Mbps, or 1 Gbps. Gigabit Ethernet will link servers and LAN segments and is thought to be more attractive than ATM, because it behaves like Ethernet.

● ■ **Asynchronous transfer mode (ATM)** A cell-switched networking technology suitable for LANs as well as WANs because of its inherently scalable design. ATM, however, might never be widely deployed for desktop connections. ATM runs from 25 Mbps up to 655 Mbps or faster.

■ **ISDN** A digital service for sending data and voice. ISDN is available with a *basic-rate interface* (BRI), which provides up to 128 Kbps, or with a *primary-rate interface* (PRI), which provides up to 1.544 Mbps.

■ **Leased line** A private, nonswitched, dedicated communications line, which contrasts with dial-up lines like ISDN or telephone-service lines. Today, most companies' WAN connections are leased lines, typically running at 56 Kbps or 1.5 Mbps.

■ **Frame relay** A packet-switching networking technology designed for sending data over wide area networks that is more efficient than leased line. Frame relay can transmit at variable rates, from 56 Kbps to as fast as 155 Mbps.

desktop, promoted in products from IBM and other companies, might never overcome the inertia of installed Ethernet systems. It now appears that ATM will evolve as a replacement for frame relay in subscription wide area services. An individual user's application can request specific QOS handling from the ATM network for streams of data, yielding a network that's more than just dumb pipes. ATM backbone networks running at 155 Mbps, 622 Mbps, and faster will feed data to the new residential delivery systems, such as cable modems and the telephone digital subscriber links described in "Home Connectivity."

• **High-level switching.** As a technology, switching is ancient. Many concepts incorporated in turn-of-the-century telephone switches find their way into today's ATM and Ethernet switches. The latter were adopted when individual LAN segments grew to have so many busy nodes that sharing the connection became a problem. Switches store and forward packets and appear to give each node a path into the network without contention. Unfortunately, the concept of switching in both ATM and Ethernet breaks down when applications try to broadcast data to all nodes at once.

Competing groups of vendors are touting more sophisticated switches that examine each packet to determine how it should be handled, based on the originating application, instructions from the destination, and other factors. The problem of broadcast packets isn't unique to large networks, and high-level switches are likely to become an important part of the traffic management and security of all business-critical networks in three to six years.

• **Wireless WANs.** The next few years promise to bring several new high-speed ground- and space-based wireless data services that can provide instant connectivity anywhere. The important wireless technology happening right now is the replacement for the analog cellular phone systems used in North America, referred to as *Personal Communications Service* (PCS). Initially, the appeal of these technologies is not speed: You'll typically get digital signaling speeds of about 13 to 14 Kbps—slower than a V.34 modem. But the connections are good enough for the use of compression, and unlike analog cellular service, they're very reliable. Digital service is becoming real now, with recent roll-outs of service from Sprint PCS in Fresno, Milwaukee, Spokane, and Portland. Many other companies, including regional carriers like Ameritech and GTE, are starting digital service this year.

But the terrestrial PCS carriers will face stiff competition from a higher plane. Within the next four years, the sky will be dotted with broadband digital satellite services from Loral Space and Communications' CyberStar, Motorola's M-Star, Hughes Communications' SpaceWay, Teledesic Corp., and AT&T's VoiceSpan. These companies have a variety of schemes and announcements, but they typically include 2 Mbps to 6 Mbps of digital service. Many organizations, particularly those with international operations, will benefit from these fast, competitive digital wireless services.

• **Fast Ethernet.** Fast Ethernet rolled over competitors and emerged as the favorite way to link file servers, databases, and Web servers into local networks. Fast Ethernet is also arriving as a desktop technology. Implemented in wiring hubs and LAN adapter cards, Fast Ethernet is now a core technology that will power networks for a decade to come.

• **Gigabit Ethernet.** Gigabit Ethernet systems, shipping in 1997, will merge Fast Ethernet's big pipes into aqueducts of data within the LAN and among LAN segments in a campus network. Unlike ATM, this technology is emerging as a mature solution with a purpose. Gigabit Ethernet will be the campus and enterprise backbone beyond 1999.

EMERGING BUSINESS NETWORKING

SWITCHING TO FASTER NETS

The combination of next-generation switching products and standards will give networks more flexibility and intelligence. **By Frank J. Derfler, Jr.**

The best advice for network planners today is, "Switch when you can, and route if you must." The philosophy behind it is that switching is a simple hardware-level task that happens quickly, with little management overhead, whereas routing requires complex software and an extensive overhead and management structure.

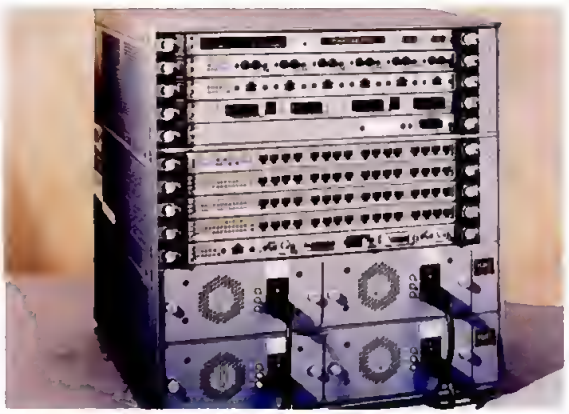
Contemporary networks use *routers* to determine which packets cross local and wide area links between LANs. Because of routers' complexity, greater overhead, and management difficulties, network designers are now turning to hardware *switches* to do the job instead. Like routers, today's switches read destination addresses and take actions, but a switch's action is a simple hardware response, and the switch relies on other switches in the path to have more detailed information about the destination.

It used to be that common interest groups within a company—those generating high traffic among themselves—were clustered together. Today, common interest groups are increasingly made up of members in many different locations, scattered all over the country if not the world. This arrangement leads to virtual networks: nodes of consistent heavy traffic without geographical commonality. Frame relay currently has capabilities for predetermined virtual networks, but new switches increasingly will be able to recognize virtual network traffic and give it special or more economical handling.

FAST, LEAN NETWORKS

Frame-relay switches handle large packages of data efficiently. The switches can differentiate among the priorities of different groups of users and offer a guaranteed minimum level of service. ATM, frame relay's successor in wide area networks, chops data streams into tiny packages called *cells* and then overcomes the inefficiency of transferring small packages with today's fast and affordable processing power. Along with the ability to handle video and audio efficiently, ATM switches can respond to requests for special handling contained within each cell. While this quality of service (QOS) feature is not unique to ATM networks, ATM is the first networking technology to have QOS features built into its architecture. Leading ATM vendors include FORE Systems, Cisco Systems, IBM, Newbridge Networks, and 3Com Corp.

Switching is fast, easy to install, and relatively inexpensive, but it falls apart when general broadcast traffic, such as training or news feeds or even network games, floods the network. Vendors such as Bay Networks, Cisco, IBM, Ipsilon, and 3Com are developing higher-level switching systems that carry many different names, like IP Switching, Fast IP, and Tag Switching. These systems look deeper into a packet, cell, or frame to determine what application sent it and how it should be handled. A stream of video or a long file transfer between two points will trigger special handling. Broadcasts will be handled according to destination-specific rules set up in the switch.



FORE Systems' PowerHub 7000, an ATM switch.

These companies are pushing proprietary ideas and have positioned themselves in the competitive and cooperative process of developing standards. Some standards—particularly those determining how switches and other devices set up virtual networks and how they look inside packets to determine QOS—will emerge this year. Others, such as those defining how switches dynamically determine the best path to a destination, will follow. In the next three to six years, these high-level switches will gradually become a critical part of modern networks that need special services for specific kinds of data.

PLANNING FOR THE DECADE

How should you prepare for all these fast-connection alternatives? The enterprise wiring closets are the key to economical growth. To be ready for tomorrow, your wiring closet should have a chassis-based switching hub with a fast internal backplane.

Chassis-based switches aren't cheap. They're investment-grade hardware. You can set up a simple network today using a single $2,000 stackable hub; such a network would require an initial investment of $20,000 using a chassis-based switch. But upgrading the stackable hub system to add dozens of new ports, switching, and Gigabit Ethernet—or, for WAN links, frame relay or ATM—probably means attaching a completely different device. Each new device involves adding another Ethernet segment, reconfiguring to avoid breaking rules regulating the number of segments, and disrupting the whole LAN. Upgrading a chassis-based switch involves simply adding a slide-in module, and the power stays on. Other benefits of chassis-based switches include centralized and extensive management features and the fast internal backplane that connects each module, avoiding the problems of too many segments.

We'll briefly describe four chassis-based Fast Ethernet switch systems from Cisco Systems, 3Com Corp., Cabletron Systems, and IBM that will provide a sound basis for a decade of growth. Each of these is a rack-mountable cabinet with a fast internal backplane and a family of add-in modules, often referred to as "blades" because they are long and thin. In addition to the vendors we discuss below—examples of good investment strategies for tomorrow's data

systems—a list of companies with products in this category would include Bay Networks, Compaq Computer Corp., Digital Equipment Corp., FORE Systems, Hewlett-Packard Co., Optical Data Systems, and Xylan Corp.



The Cisco Catalyst 5000.

CISCO CATALYST 5000

The Cisco Catalyst 5000 switch, a core product in the Catalyst family, has four available expansion slots for flexible connection options. You can mix and match the open slots with LAN modules for 10-Mbps Ethernet using various types of cables, Fast Ethernet, Fiber Distributed Data Interface (FDDI), and other options. You can choose to add 100-Mbps FDDI and 155-Mbps ATM wide area communications modules to form the backbone of connections among wiring closets. Inside the cabinet is a backplane operating at 1.2 Gbps that carries data and management information among the modules.

3COM LANPLEX 6000

No company is more devoted to Gigabit and Fast Ethernet than 3Com. Although the company is talking a lot right now about the SuperStack II family of stackable hubs for workgroups, it's the LANplex 6000 series of chassis-based Ethernet switching systems that is designed for corporate wiring closets. 3Com promotes the Ethernet-to-ATM and Ethernet-to-FDDI handling capabilities of its LANplex products. New LANplex modules will allow you to make ATM connections at up to 622 Mbps.

CABLETRON MMAC

Cabletron's MMAC and the larger-capacity MMAC-Plus families of chassis-based hubs and switches are another industry standard. The MMAC SmartSwitch family includes various cabinet configurations and several options for Fast Ethernet switching. Cabletron is stressing its commitment to Gigabit Ethernet. The company says its announced Gigabit Ethernet SmartSwitch will switch up to 28 separate Gigabit Ethernet segments within a single chassis, which according to Cabletron will make the MMAC-Plus the industry's highest-port-density Gigabit Ethernet switching platform.

Although Cabletron's list of WAN options isn't as long as IBM's, the company offers flexible FDDI and ATM alternatives.

IBM NWAYS

IBM's huge Nways family of chassis-based systems includes the 8274 Nways system, which has several chassis configurations for floor or rack mounting. IBM's catalog lists more than 70 add-in modules for the 8274 family, including all the usual LAN connections and a wide variety of WAN links. There are five different switching modules with various capabilities. If you have Token-Ring networking now, IBM is ready to help you replace it with 25-Mbps ATM to the desktop. The IBM chassis has a 2-Gbps backplane, a mind-boggling set of management options, and the ability to hold dozens of frame-relay, ATM, or FDDI ports.



The IBM 8274 Nways LAN RouteSwitch Model 500.

NEXT-GENERATION ETHERNET

"Ten times the speed at only three times the cost!" That's the rallying cry of the Gigabit Ethernet Alliance, and its members are charging fast. Their multiples apply to 100-Mbps Fast Ethernet: Gigabit Ethernet is designed to provide 1,000-Mbps throughput, or 1 gigabit per second. But don't be confused: Fast Ethernet is an ally; the enemy is ATM. Although it's a little early to raise the arm of the victor, it won't be much of a fight on local area network backbones.

Nothing in the original Ethernet specification of the 1980s limits its speed. The methods of packaging data and controlling access to the network that work at 10 Mbps also work at 1,000 Mbps. With so much Ethernet in place, it's natural to use the same technology that takes data across the office to move it across the campus. Unfortunately, built-in limits on the distance between nodes make pure Ethernet less practical beyond a few miles. It won't provide links between cities, but using fiber-optic cable, it can do a great job across a campus or within a corporate headquarters.

The developers of Gigabit Ethernet—let's call it GigE—are on a fast track. They took technology from the widely used Fiber Distributed Data Interface (FDDI) and married it to Ethernet. GigE will replace FDDI in many installations. Dozens of companies, including both established giants and startups, are betting large sums on GigE.

As this article entered its final preparation stages, it was still a few weeks too early for us to see GigE products that conform to even a draft standard. Like other LAN protocols, the standard is overseen by the IEEE (Institute of Electrical and Electronics Engineers), a publishing and standards-making body that is responsible for many computing standards. The draft of the 802.3z standard for Gigabit Ethernet was opened for comments in January and should be voted on in June. You'll be able to buy and install real GigE products in the second half of this year.

The router and switch companies, including Bay Networks, Cisco Systems, and 3Com Corp., strongly support GigE and will have modules for their existing chassis-based products. Cisco recently made a $220 million commitment to Gigabit Ethernet through its purchase of Granite Systems. Sun Microsystems is one company that sees GigE reaching beyond the backbone and into servers, so you should expect to see adapters for Sun's hardware among the early products.

Not everybody needs Gigabit Ethernet. In offices with hundreds of typical nodes, 100-Mbps Fast Ethernet will provide all the capacity you'll need. But if your company numbers its nodes in the thousands, or if your network is running specialized high-volume applications, then the huge backbone capacity of Gigabit Ethernet will be in your future. □

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FUTURE HOME CONNECTIVITY

New digital technologies will deliver services that match the power of PCs.

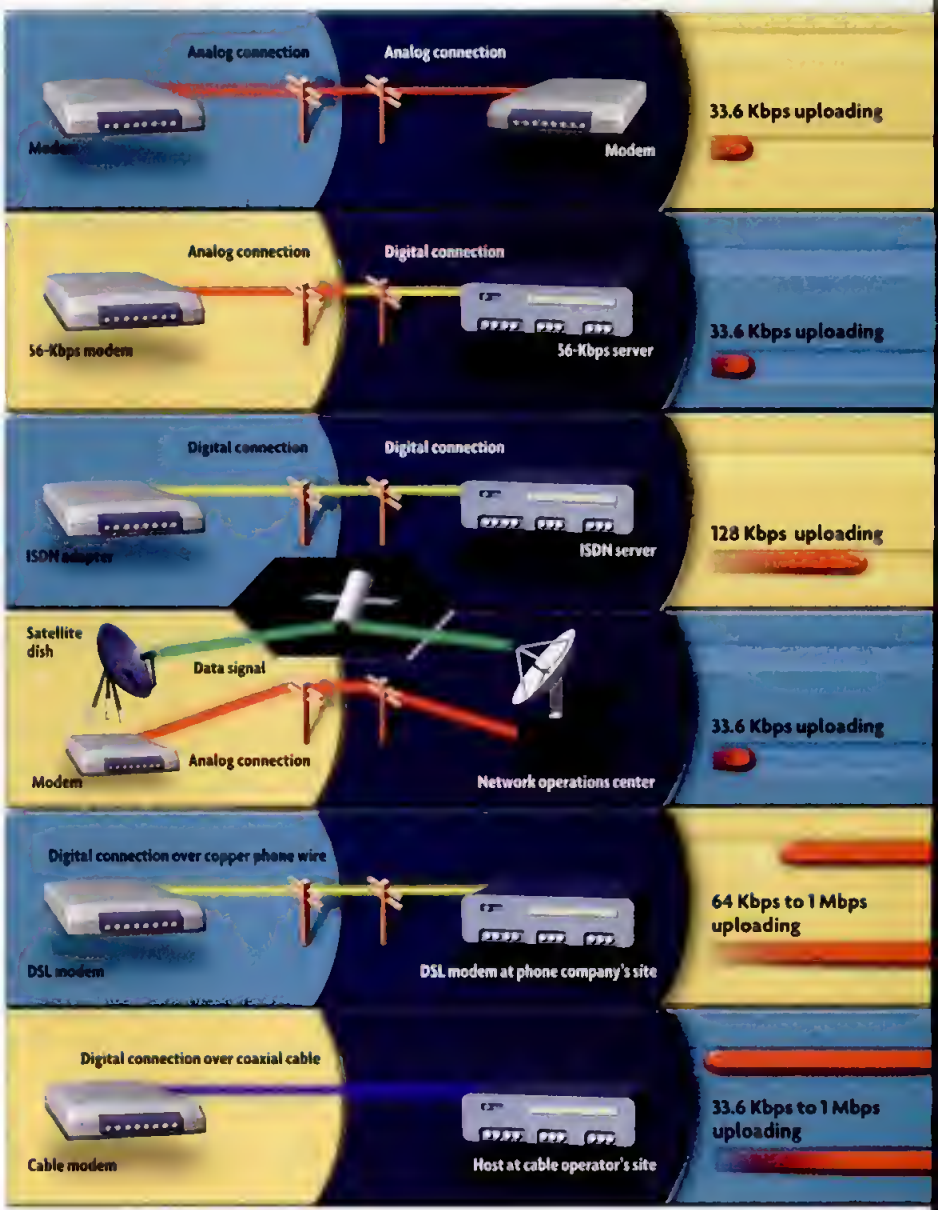
By Les Freed

Compared with the power of your PC, analog modems are agonizingly inadequate. Using a modem with today's Pentium Pro machines is like towing a Concorde jet around with a lawnmower. For remote connectivity, most of us still dial up using the same old modem technology over telephone network equipment that's been around for decades.

Modems are much faster than they once were, having increased from 300 bits per second (bps) to 33.6 Kbps. Each successive improvement in modem speed feels fast enough for a while, but it's not long before the content we're viewing and downloading becomes larger and more complex, making our fast modems feel slow again. The main culprit responsible for our bandwidth lust is ubiquitous Internet access. It whets the appetite, but the sluggish modems leave people starving for speed.

Exciting new technologies promise to change all that in the next 15 years with drastic increases in bandwidth capacity. Several viable alternatives to analog modems are here today or are appearing on the horizon: ISDN, 56-Kbps modems, digital subscriber line (DSL) modems, cable modems, and satellite data services. With these technologies, we're going to see new kinds of interactive content that take advantage of megabit-per-second pipes into the home—not just on-demand movies, but realistic 3-D multiplayer games and interactive video forums. We'll also see new ways of working from home, as connecting to the office becomes a richer experience with fast connection speeds and new applications.

By 2000, we expect that the majority of *PC Magazine*'s readers will have 56-Kbps or faster connections to their home



computers. That's assuming the 56-Kbps modem technology bursting on the scene this year really works on the majority of installed residential telephone lines. By 2005, more than half of our readers will have connections with better than 2-Mbps throughput.

INSIDE

ISDN ADAPTERS
56-KBPS MODEMS
SATELLITE DATA SERVICE
DSL MODEMS
CABLE MODEMS

The technology behind each outside connection will depend on local politics and geography. Regardless of the device, these connections will work invisibly through routers or switches, giving home users instant access to Internet and corporate intranet services.

Today, the where and when of fast residential service are two big unanswered questions. We do know that you'll eventually replace your modem with a high-speed digital communications device, but it's not certain what technology it will be, nor can we tell who might provide the service in your area. But it's safe to assume that as with ISDN, all of these services will become available gradually, neighborhood by neighborhood. For the foreseeable future, geography is destiny.

THE GREAT BANDWIDTH RUSH

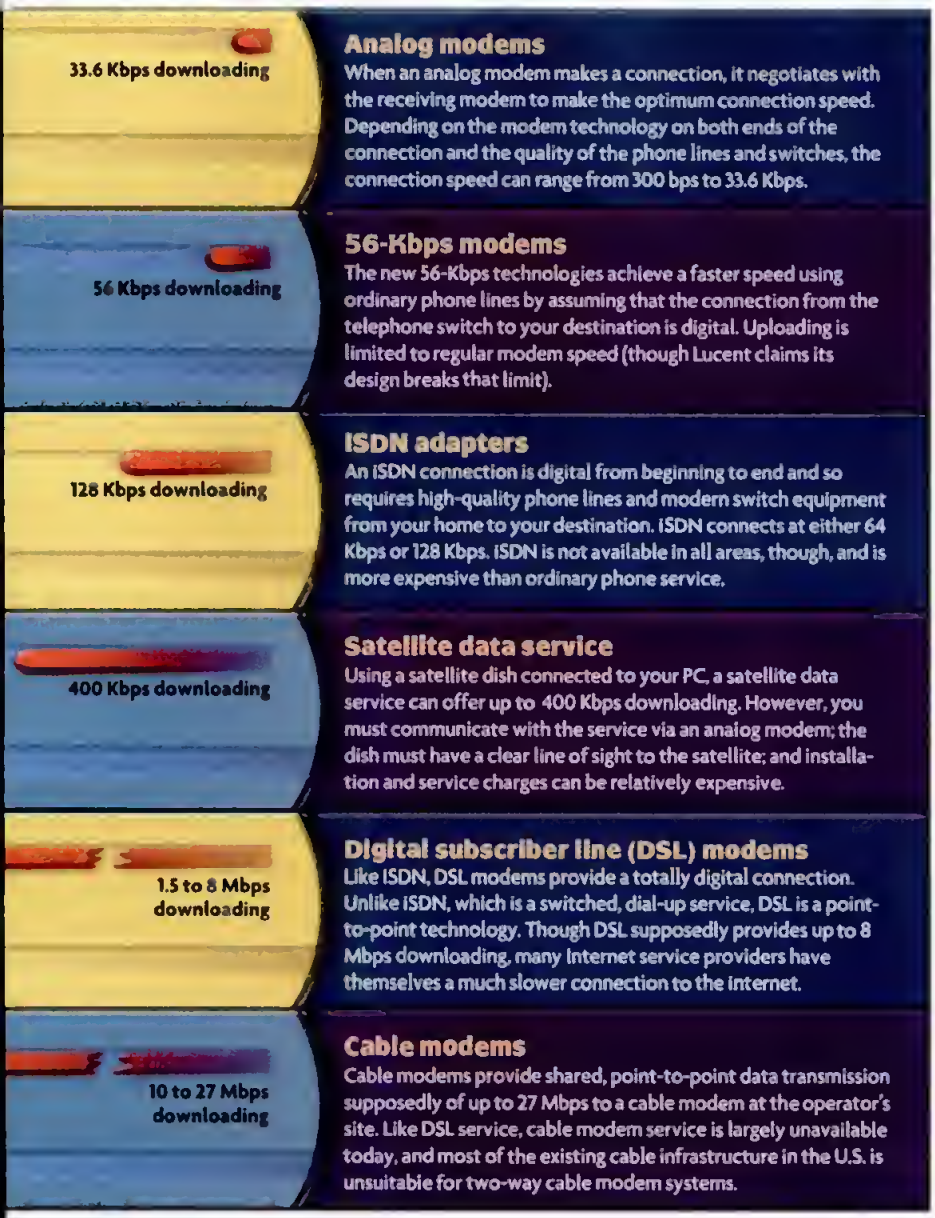
All kinds of businesses are swooping in to fill the speed gap with the new technologies. The telephone companies that provide data services via a two-way copper path to the home today—once the only game in town—are under siege. The Telecommunications Act of 1996 opened the regional phone companies to competition even for local dial-tone service. Jumping into the mix with phone companies are cable operators and satellite services. We might also see Internet service providers (ISPs), alternative local phone-service providers (called competitive access providers, or CAPs), wireless data companies, and even utility companies offering high-speed data services.

Most of the technologies that these competitors are basing their services around are still immature: 56-Kbps modems, cable, and DSL have limited deployment and no solid industry standards yet. Even established technologies like ISDN and satellite data service have not yet reached a large audience.

Much of the problem for these new services is that right now they're having to adopt two hats: that of the *communications service provider* and also that of *content and Internet service provider*. In the world of analog modems, the phone companies provide the connection, and ISPs or online services add Internet access and content. The new companies face not only higher costs—hindering their prospects for quick deployment—but also the high hurdle of producing compelling content while supporting the physical network. In the next few years, we'll see new companies (or "content partners," in the parlance of the cable service @Home Network) that produce high-bandwidth content for cable and DSL providers, just as HBO and ESPN deliver their content through cable TV operators today. The economies of scale are better in this model, and the content is likely to be more interesting as well.

A more ominous obstacle to high-speed home connections is the possibility that large-scale demand to support these kinds of services may not exist. ISDN has languished for years (though not entirely because of lack of demand). Time Warner's recent interactive television trial in Orlando, Florida, revealed that customers value the ability to order stamps far more than they value high-bandwidth services like on-demand video.

Some industry figures have even pre-



dicted a spreading cyber-malaise. "I wouldn't be surprised to see an Internet backlash soon—a 'Net weariness,'" said IBM CEO Louis Gerstner Jr. in a keynote address at last fall's Internet World trade show. "All those end users wondering if this is a waste of time; all those businesses wondering if this is a waste of money." Such sentiments are not what you want to hear if you're preparing to spend millions of dollars setting up an Internet access business.

Nevertheless, we think these technologies will arrive at your doorstep in one shape or another. Here's an overview of what's happening with each of them, the challenges they face, and where they're headed.

• **ISDN.** Designed in the early 1980s as a digital replacement for analog telephone service, ISDN (Integrated Services Digital Network) connects your home or office to a telephone company's central office switch using a single pair of wires. That's an important point, because it means—at least in theory—that phone companies can easily convert existing analog phone customers to ISDN. But when it became available, ISDN was torturously difficult to order, and getting the hardware installed was a headache. Recently, a surge of interest in ISDN, fueled in large part by a demand for faster Internet access, has resulted in a new crop of ISDN equipment that is virtually self-installing.

The downside is that ISDN still isn't universally available in the U.S. (though it's widespread in Europe and Japan), and it can be expensive–about the same as the price of two analog lines, not including usage charges. Depending on your local phone company tariffs, you may pay a per-call connect charge in addition to per-minute billing on data calls. Some feel that ISDN is a technology whose time came and went. Whereas 64 or 128 Kbps once seemed like all the speed in the world, ISDN doesn't provide a quantum leap beyond V.34 modems. And while today ISDN is the most widely available and mature of the technologies discussed here, 56-Kbps modems–if they work for most users–could take the wind out of its sails for good.

• **56-Kbps modems.** Promoted practically to the point of exaggeration by U.S. Robotics, Lucent Technologies, and Rockwell Semiconductor Systems, these new techniques for 56-Kbps transmission over phone lines can be considered the modem's last stand. But their allure is obvious. Though only about half the full speed of ISDN, 56-Kbps modems have the potential for rapid rollout (unlike ISDN), and there are no monthly or per-minute charges for 56-Kbps service from the telephone company.

Exciting technologies promise to increase the bandwidth to your home dramatically–but where and when?

The drawbacks cannot be ignored. You will still need a good-quality phone line to your home, and you will have to be within a mile or two of the phone company's switch—which means that some rural areas won't ever see 56 Kbps. You need to access a service provider that has the hardware support for whatever 56-Kbps scheme you are using. The host you're calling also must have a digital connection to the Internet or corporate network. Uploading speeds are slower. Most important for the near term, all 56-Kbps solutions today are proprietary, and standards are not expected before next year. But the core network infrastructure is largely in place for 56-Kbps service, which looks to diminish the appeal of ISDN for data services over the next ten years.

• **Satellite data service.** Hughes Network Systems, a division of Hughes Electronics, last year launched high-speed data service over its satellite system, offering up to 400-Kbps downloads (though the one-way system requires a modem link for the back channel to the service). Satellite data delivery has its share of drawbacks, including relatively costly start-up fees, but like ISDN, it's here today. Unlike ISDN, it's available anywhere in the U.S. that has a clear line of sight to the service's satellite. It's a great technology, but depending on the physical layout of your home or building, satellite data service may not be a viable option.

• **DSL modems.** Digital subscriber line and cable modems are technologically very different but conceptually similar. Both provide dedicated multimegabit connections, so your service is always on, unlike dial-up connections. The phone companies and equipment vendors claim DSL—which essentially operates as high-speed leased lines over copper wiring—can reach speeds of up to 8 Mbps, not as fast as the cable camp claims for its technology but still light-years ahead of 33.6-Kbps modems.

As with cable modems, large-scale implementation of DSL will require a substantial investment. The telephone companies have managed to put a positive spin on new DSL technologies, creating the impression that they are deeply committed to providing fast data services in the near future. But gauged against the phone companies' success in promoting ISDN as a high-speed service, the prospects for a fast DSL rollout don't look promising.

As suppliers of a consumer-oriented service, DSL providers face the challenge of producing compelling, affordable, high-speed content. In the near term, there's probably a better chance that DSL will be geared toward businesses that want to accommodate telecommuters or connect their networks for Internet access.

• **Cable modems.** Cable television companies and cable modem equipment vendors talk boldly about cable modems and their claimed 27-Mbps throughput. But few cable operators talk about the costs needed to make their systems bidirectional or to route the data onward once they've collected it. In the next five to seven years, you're much more likely to see fast cable downloads with analog telephone modem uploads than to get real two-way cable modem service. And unless you're very lucky and happen to live or work in the right place, you won't be able to get cable modem service soon.

In addition to the technical challenges, cable modem ventures are faced with the difficulty of generating unique localized content that takes advantage of the high speeds the technology offers. In order to compete with the phone companies and other high-speed service providers, the cable services will have to convince customers that the content they provide is worth paying for. So far, cable trials, flush with venture-capital cash, simply haven't been market-tested on a wide scale.

YOU DON'T HAVE TO BE ON A PLANE TO FLY.

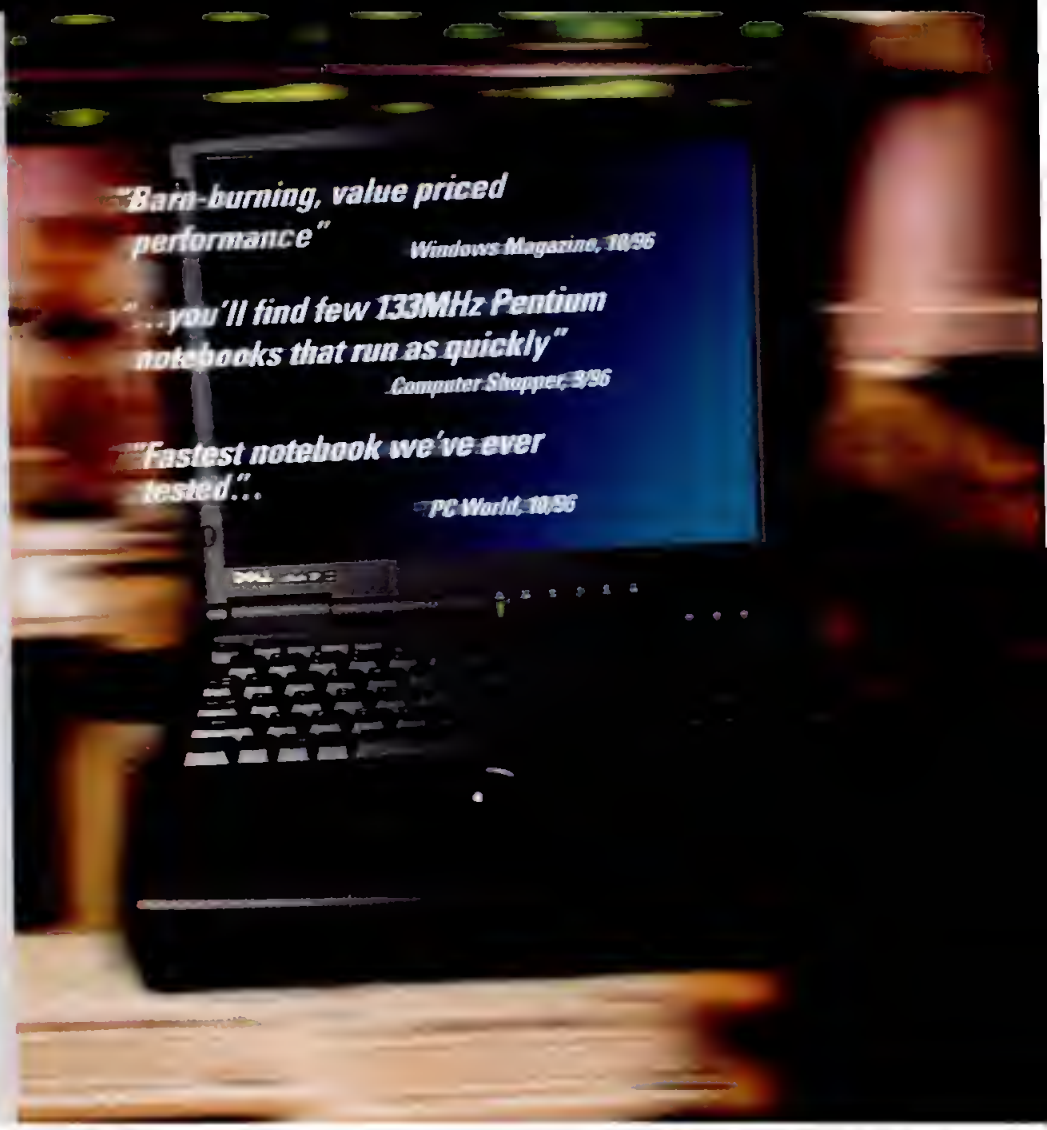
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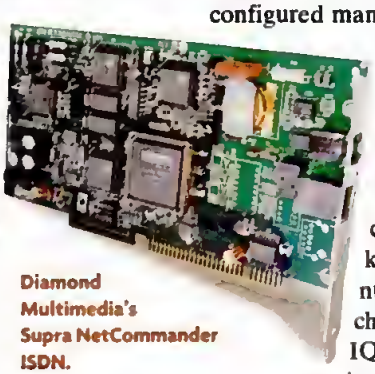
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EMERGING HOME CONNECTIVITY

A MARKET SET TO IGNITE

Equipment vendors and service providers will bombard us with competing—and confusing—options for high-speed access. **By Les Freed**

Although ISDN hasn't lived up to expectations and may soon be roadkill in the wake of 56-Kbps modems, it's a mature technology that's in use today. In recent years, ISDN adapters have improved dramatically in ease of installation and use. Despite your neighbor's complaints about her difficulties obtaining the service from the phone company, in the next year or two you have the best chance of actually getting ISDN of any of the fast technologies discussed in this article.



Diamond Multimedia's Supra NetCommander ISDN.

Here we review two of the best ISDN adapters, Diamond Multimedia Systems' internal Supra NetCommander ISDN and 3Com Corp.'s 3ComImpact IQ external ISDN modem. (For a complete roundup of ISDN adapters, see "Digital Dragsters," February 4, 1997.)

DIAMOND MULTIMEDIA SUPRA NETCOMMANDER ISDN

Diamond's Supra NetCommander ISDN breaks new ground in the internal ISDN adapter market with a $249 list price, making ISDN fully cost-competitive with V.34 modems. Diamond didn't cut any corners to make that price point, either. The ISA-based NetCommander provides simple installation, a single full-featured analog jack for a telephone or fax machine, best-of-breed software, and excellent performance. An onboard LED provides visual confirmation that your ISDN line is working. Diamond's innovative AutoISDN software graphically displays the status of each of the two ISDN B-channels. AutoISDN also shows the number called and length of call for each call, and it can display Caller ID data for incoming calls, if the service is available.

3COMIMPACT IQ

The $499 3ComImpact IQ is 3Com's second-generation external ISDN adapter, and it's the easiest adapter to install we've ever seen. Most ISDN adapters must be configured manually. The 3ComImpact IQ's configuration software automatically detects the type of central office switch it's connected to and service provider ID (SPID) codes; all you need to know is your telephone numbers for the two B-channels. The 3ComImpact IQ includes two analog jacks, and you can program either one to connect to one of the two ISDN B-channels.

56-KBPS MODEMS

Modems are like a character from a Stephen King novel: Just when you think they're dead, they come right back again. Less than a year ago, the conventional wisdom in the modem industry was that the 33.6-Kbps V.34 specification would be the industry's last major step forward.

The modem monster isn't quite dead yet. Last fall, almost simultaneously, three companies—U.S. Robotics, Rockwell Semiconductor Systems, and Lucent Technologies—announced that they were working on separate 56-Kbps modem technologies. The companies have different implementations, and they are probably at least a year away from an interoperable standard, but they'll be shipping products within months. Your choice of whether to purchase one will depend on your ISP's or company's choice to buy into one of the proprietary solutions. If you're lucky, you may be able to upgrade your modem through a software or firmware upgrade.



3Comimpact IQ external ISDN adapter.

We haven't had hands-on experience with a real, live 56-Kbps modem yet. U.S. Robotics, the first vendor to promise products, was unable to send us products employing its x2 technology so we can't report on their performance yet. Companies using the Rockwell and Lucent chip sets have announced plans to deliver 56-Kbps products later this year.

If the 56-Kbps technology works on a sizable percentage of existing telephone lines—and that has not yet been demonstrated—then it will seriously dent the growth of residential ISDN. The two primary uses of 56-Kbps modems will be from home to the ISP and from home to the office, both areas of ISDN growth. The huge advantage of 56-Kbps modem technology is that while it's almost as fast as a single B-channel ISDN connection, it doesn't come with any of the installation costs and usage fees of ISDN.

U.S. Robotics' x2 technology provides an example of how 56-Kbps modems work. The current V.34 modem standard was designed with the assumption that both calling and answering modems would be attached to ordinary analog phone lines. To achieve 56-Kbps speeds, x2 assumes that the host end—the x2 Server, in U.S. Robotics' jargon—is attached to a digital line, such as T1 or ISDN services. The client modem uploads data at up to 33.6 Kbps (though Lucent recently claimed that its technique could achieve 40 Kbps upstream).

Ordinary modems send digital data over analog phone lines by converting the computer's binary data stream into a series of modulated tones. The digital-to-analog-and-back-again conversion process introduces a certain amount of distortion into the digital signal. The V.34 standard assumes that this conversion process will take place twice, once at each end of the connection. x2 eliminates the analog-to-digital conversion at the server end, allowing for a higher-bandwidth connection.

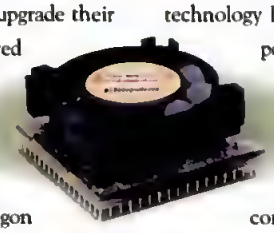
Now for the caveats: Unlike bona fide modems, x2 client modems can't connect with each other at 56 Kbps, so x2 modems

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will fall back to V.34 if you try to connect two of them together. The calling modem must be no farther than a mile or two from the phone company's digital switch to achieve 56 Kbps. And to call an x2 server, you'll need an x2 client modem, since no standard for 56-Kbps transmission is expected until at least 1998. Standards debates are nothing new in the modem industry, and we expect that all parties involved will work together toward a unified standard approved by the ITU, the International Telecommunications Union, a Geneva-based organization that maintains telecommunications standards.

U.S. Robotics plans to provide x2 as a free firmware upgrade to some owners of the company's flash ROM–based modems. (U.S. Robotics provides information about x2 technology at *x2.usr.com*.) Rockwell and Lucent have announced plans to make their 56-Kbps technology interoperable—in a protocol called K56flex—but neither will be compatible with x2. Although neither Lucent nor Rockwell manufactures modems, both supply modem chip sets to major vendors, including Hayes and Microcom.

SATELLITE DATA SERVICE

Currently, Hughes Network Systems is the only provider of satellite data service in the U.S. Though expensive and not practical for everyone, satellite data service may be the high-speed Internet system you're looking for. In the future, competing satellite services should drive down the costs, and bidirectional data transmission could sweeten satellite data's appeal for home and business users alike. Here we take a look at Hughes' DirecPC as it's available today.

DIRECPC

DirecPC is a $499 package (installation charges are extra) that includes a 21-inch dish, an ISA card, and assorted cables and software. In the U.S., the dish must be installed so that it has a clear view of the southern sky, and you must run a coaxial cable from the dish to your PC. You'll also need a 28.8-Kbps modem and a phone line for your outbound data, since the satellite system is broadcast-only.

Once you hook everything up and install the software, DirecPC can provide you with stunning download speeds. Hughes claims a top speed of 400 Kbps. We like the DirecPC technology, but this product isn't for everyone. Installation is not extremely difficult in a typical single-family home, but the dish's positioning and cabling requirements rule out its use in most condominiums, apartments, and office buildings.

Besides the up-front expense, there are usage costs, and they can add up. Hughes offers a variety of pricing packages starting at $39.95 a month and ranging up to $129.95 per month for unlimited use during specified hours; depending on the plan and when you call, you incur additional charges of 60 or 80 cents per megabyte downloaded. There's also a $9.95 per month access fee, and you'll need a dial-up account with another Internet service provider for your outbound data.



Hughes Network Systems' DirecPC satellite dish.

DSL MODEMS

Digital subscriber line (DSL) service is, in many ways, a better ISDN than ISDN. Like ISDN, DSL is a service that you'll subscribe to from a telephone company or another local provider. And like ISDN, DSL uses existing copper lines to carry data from the phone company's central office to your home or business. But unlike ISDN, DSL is a point-to-point—not dial-up—service.

DSL is an all-digital service, and it promises to deliver data at speeds ranging from 1.5 to 8 Mbps or better. You'll hear about ADSL (asymmetric digital subscriber line), HDSL (high-bit-rate digital subscriber line), RADSL (rate-adaptive digital subscriber line), and maybe even other variations. These signaling techniques vary, but the idea is that the link is faster in one direction than in the other. The reverse channel speeds range from 64 Kbps to 1 Mbps. The differences between the competing technologies don't matter much to you, because you'll probably get all of the equipment and service from a local telephone company or another service provider.

There are dozens of announced DSL products from big-name vendors like Paradyne Corp. (formerly part of AT&T), Motorola, 3Com, and IBM, as well as a host of smaller start-up companies. A few products are even shipping, in limited quantities.

DSL isn't commercially available yet, but several trial installations are up and running. At least two phone companies—US West and GTE—plan to offer DSL service in a few limited markets early this year. Most of the trial installations are being used to connect telecommuters to LANs. That seems to be the phone companies' major focus for DSL, at least for the time being, and DSL's point-to-point nature makes it ideal for this duty: The link is always up, and the service should be very reliable. Many home users want a faster connection to the Internet, but DSL may not be the answer for them in the next few years.

To connect home users to the Internet, the phone companies will have to act as ISPs for their DSL customers, or else they'll have to strike deals with ISPs willing to invest in DSL. But there's a problem: Many ISPs don't have enough backbone bandwidth to support hundreds of customers with multimegabit connections. DSL is faster than the backbone link that connects many ISPs to the Internet. A single 1.5-Mbps T1 link to the Internet can support 53 V.34 modem users or 24 ISDN users—but only one DSL user. ISPs and phone companies that are serious about providing Internet access via DSL will have to spend considerable money to upgrade their Internet links.



Paradyne's HotWire DSL modem.

The phone companies may find themselves under pressure to adopt DSL sooner than they would like. DSL operates over *dry pair* lines, dedicated end-to-end copper lines that do not pass through the phone company's switching equipment. Dry pair lines are less expensive than ordinary phone lines, so the phone companies don't make much money on them. In the past, dry pair lines have been used primarily for dedicated intercom circuits and for low-speed point-to-point data links.

InterAccess, a Chicago-based ISP, is leasing dry pair lines from the local phone company and providing customers with its own DSL service. For a $1,500 up-front cost (which includes the DSL equipment) and $200 per month, InterAccess provides its customers with full-time 1.5-Mbps Internet access. While too costly for most home users, this pricing is very competitive compared with leased line rates that many businesses use for Internet access.

There's nothing keeping any ambitious company from ordering dry pair lines and providing its own DSL equipment for remote-access or LAN-linking duties, and many DSL equipment vendors are actively encouraging users to do just that. If the idea of private DSL networks running over phone company–provided dry pairs takes off, the phone companies may find themselves relegated to being the wiring hub for a large number of private data networks.

CABLE MODEMS

A telephone company might offer DSL to your home, but the local cable television company can counter with cable modem service. That could be a powerful alternative, but the service requires a large investment in a geography-spanning infrastructure. In most of the current plans, cable modem service is delivered to your home as an Ethernet connection. Like Ethernet, the cable modem system is shared, so even though you might have 10 Mbps of bandwidth available, the engineering design of the system and the online habits of your neighbors will determine your actual throughput.

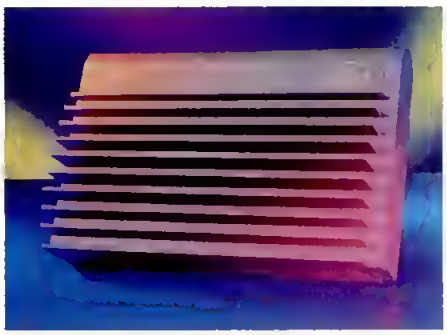
Prototype services, such as @Home Network, are becoming available in small pockets of the U.S. In some of its trial runs, @Home Network is using cable modems supplied by LANcity Corp., a division of Bay Networks. We saw a demonstration of the service at the company's headquarters in Mountain View, California. The demonstration service seemed fast and reliable, though it was slow in accessing some Web sites initially. @Home's content is basically a beefed-up Web site, larded with videos and graphics-rich pages. One of the selling points of @Home and other cable services is supposed to be its localized content, but the demo site we saw included little more in this respect than restaurant listings. Rates will vary by location, but in its trial locations @Home charges a $150 start-up fee and $34.95 per month for unlimited access—a good deal for high-speed Internet access, if you can get it and if it works.



Motorola's CyberSurfr cable modem.

Another high-profile experiment is Time Warner's RoadRunner cable modem service, which rolled out in Akron, Ohio, last fall. The service, which costs $39.95 per month for unlimited use, attracted a reported 1,000 subscribers out of 300,000 eligible homes. Initial user reports indicate that service quality fluctuates from very fast to teeth-grindingly slow during peak hours.

Cable networks are, in many ways, the opposite of the telephone network. They are primarily one-way systems, although some cable systems have a slow data reverse channel that is used for pay-per-view program selection and various types of validation data. Users might have special-service set-top boxes that can respond to broadcast instructions and appear to provide a customized connection, but typically there are no discrete circuits to each subscriber's home, as there are in the telephone network.



Bay Networks' LANcity cable modem.

Estimates vary, but about 90 percent of the nation's existing cable systems are one-way. Internet access requires a two-way link, which poses a major problem for the one-way cable systems. Some cable modem systems will use an analog modem attached to a regular phone line as the reverse channel back to the cable company. But that approach has several obvious limitations. For homes with a single phone line, it means the phone will be tied up when the user is connected to the Internet. Also, using a modem for the reverse channel means that outbound data will still travel at 33.6 Kbps, at most.

The answer—albeit an expensive one—is to replace existing coaxial cable with *hybrid fiber/coax* (HFC). In addition to a one-way coaxial radio-frequency path, for compatibility with existing cable TV, HFC provides a two-way fiber-optic cable that can be used for voice, data, and video services. Converting to HFC is not cheap, since it involves installing new cable, which is a very labor-intensive process. Many cable operators are faced with having to replace their old coax as it nears the end of its service life anyway, and for them, it would make sense to replace it with HFC.

HFC-based cable modems provide a point-to-point link, much like the link provided by DSL. So the company giving you cable modem service is going to have to install or arrange to provide a backbone service to connect you to your office or the Internet. There are now several cable modem manufacturers—including prominent vendors such as Motorola, LANcity, and Scientific Atlanta—each with its own proprietary way of doing things, but interoperability between vendors isn't a burning issue, since the cable company will supply the equipment. Cable modem systems have promise, but it will take many years for many of us to see it. □

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LOOKING BEYOND



WITH BILL GATES & GORDON MOORE

"The Internet is the place where all the neat new things are happening."

–BILL GATES, Microsoft

PC MAGAZINE DOESN'T OFTEN RUN INTERVIEWS ANYMORE. We simply have too many products we want to test at PC Labs, too many technologies we want to delve deeply into, and too many comparisons we want to run.

But on the occasion of our fifteenth anniversary, we decided to do something special. In our very first issue, the magazine ran an interview with Bill Gates called "The Man Behind the Machine?", as well as a "Boca Diary" recounting a visit to IBM PC headquarters (then in Boca Raton), which included interviews with the original PC team.

This time out, we turned to two of the pioneers of the industry. Bill Gates, of course, remains one of the most important people in the PC industry, still "the man behind the machine." His company, Microsoft, has gone from being a supplier of DOS and languages for the original IBM PC to becoming the largest force in the PC and software industry. In the intervening years, Gates himself has become the richest man in the world.

Gordon Moore founded Intel along with Bob Noyce and chaired the company through its growth as it became not only the leading microprocessor maker but also the leading force in personal computer hardware.

Both are not only company leaders but also technologists. Gates wrote early versions of BASIC for the PC and other machines, and Moore ran the labs where such things as the integrated circuit, the memory chip, and later the microprocessor first became commercial products. And in their interviews, conducted early this year by editor-in-chief Michael J. Miller, both men talked eloquently not only about the past and present of the PC industry but also about its future.



More of Bill Gates and Gordon Moore Join us online to read extended versions of the Gates and Moore interviews and to comment on their predictions in our discussion forum **www.pcmag.com.**

"...So that carries us well into the next century, and at that time we'll be able to put – I don't know, several hundred million or a billion transistors on a logic chip."

–GORDON MOORE, Intel

INTERVIEW

BILL GATES, MICROSOFT



PC: Fifteen years is a surprising amount of time in some ways. Obviously, the PC industry goes back further, but the IBM PC changed it a lot. It changed the way people thought about computers.

BILL GATES: It absolutely did. The power of the machine (because it was the first 16-bit machine), the endorsement by IBM of using a personal computer, and then the critical mass of software, distribution, and peripherals that came along with that make it the biggest milestone in the history of personal computing. It was a sea change.

MILESTONES

PC: There are some critical points in the history of the industry where if something had happened differently the whole industry might have changed somewhat. Was there one crucial point, say, in the relationship with IBM when Microsoft might not have been as dominant a company as it is today if IBM or Microsoft had done something differently?

GATES: We're certainly a strong company. I mean, we don't like the word *dominant*. The first milestone was when IBM came out to work with us. It is important to remember that the PC project inside IBM was not an important project, not a major project, not considered something that really would affect the company. This was a little foray by a small group, and IBM was more interested in proving it could do something quick than exactly what happened with the product.

So it was rather stunning when this PC later took over the word processing group, the Display Writer, and all the other small-business activities they had there. After that, the group at IBM we were working with was so large that there were many projects to replace Microsoft, where IBM wanted to do those things internally.

There was a major milestone where IBM adopted a strategy called SAA (Systems Application Architecture) and decided everything on all its computers should be more consistent. Unfortunately, this meant that the mainframe graphics group, which was in England and had a thing called GDDM, got to say the new PC operating system should use their standards instead of what we'd been doing with Windows. If OS/2 had been built to be a superset of Windows then, OS/2 could have caught on earlier. And there were many points where we tried to get things moving in that direction.

A big milestone was that the folks at IBM didn't trust the 386. They didn't think it would get done. So we encouraged Compaq to go ahead and just do a 386 machine. That was the first time people started to get a sense that it wasn't just IBM setting the standards, that this industry had a life of its own, and that companies like Compaq and Intel were in there doing new things that people should pay attention to.

Then the next milestone was when the IBM crew got really confident they could do the software themselves. And so they kept the OS/2 name and didn't end up using all the work we'd been doing to make OS/2 really strong, which became Windows NT.

ACKNOWLEDGING THE INTERNET

PC: You had a bit of a scare, a bit of a change of direction, when other companies saw the Internet and started doing things such as browsers before you did. In some respects, you changed a lot of strategies around the last few years. What did it feel like to see other companies doing things ahead of you?

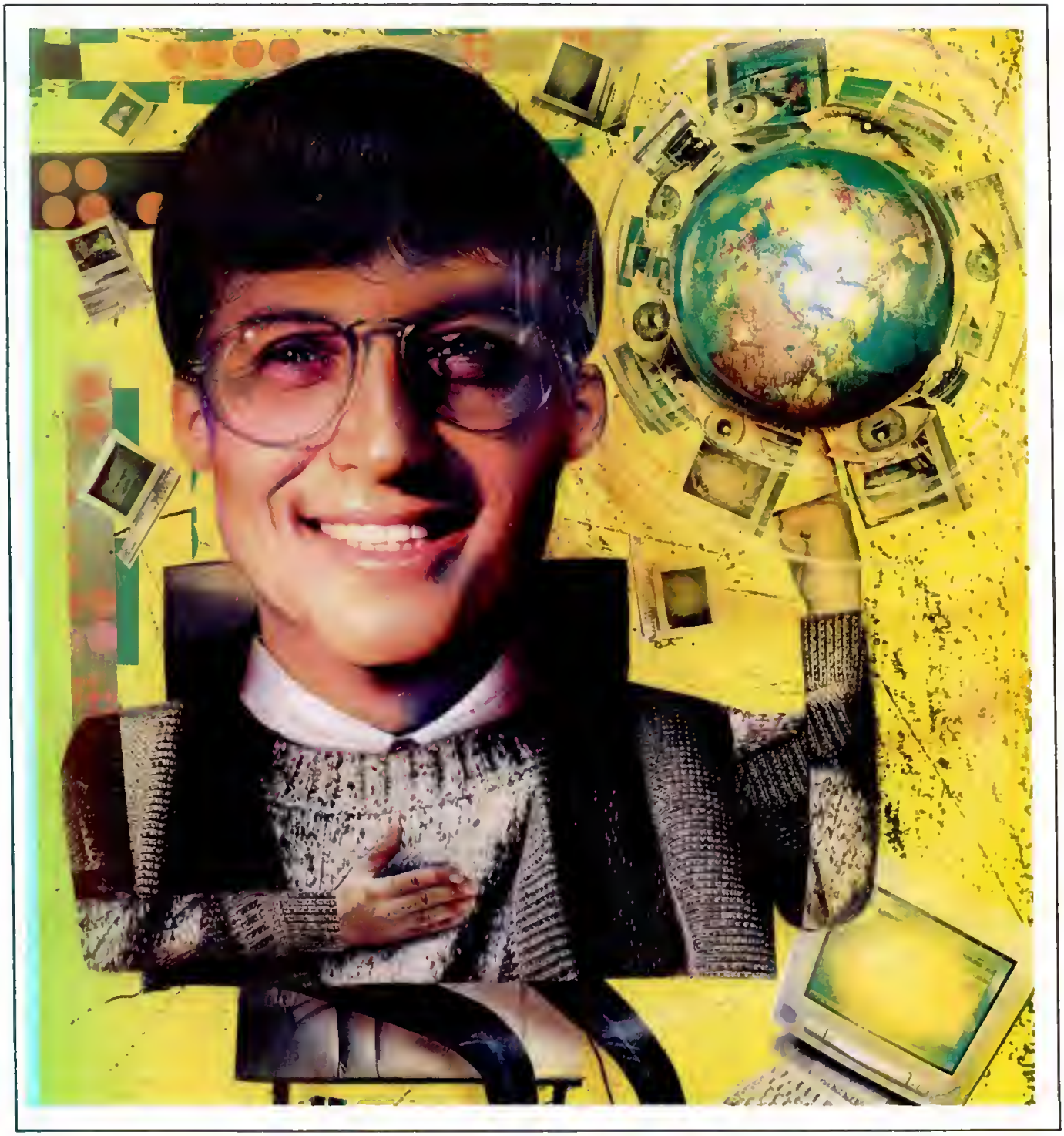
GATES: Well, I think the Internet is probably the most dramatic example of where we've had to change strategy. But I think our ability to stay ahead throughout the years has been due to our flexibility.

In the case of the Internet, it wasn't any existing companies that were doing good things. It was the phenomenon inside the universities and Netscape, which was started by people who had been part of that university phenomenon. So as that wave got going, that's where they were.

The Internet was fascinating for us because, as early as late 1994, we actually shipped an add-on to Word to do HTML support. And we had started building TCP/IP into the system and decided that that was going to be the standard protocol. Every time we'd go out and do an Internet retreat, we'd increase our view of what Internet things we wanted to do. But they were never the top priority: Getting Windows 95 done was the top priority; getting Windows NT to critical mass in the market was the top priority.

> "The Internet is still full of surprises. It's not as if you say, 'Okay, we're done with the Internet.'"

And it wasn't until really late '95 that we looked up and said, "Wow, the Internet is the vision of PCs as a communica-



tion tool coming true." It was coming true with protocols that were 20 years old. We wouldn't have guessed that this would be the case, and some nice things have been added on top of it. But fundamentally, the cost of communication coming down had led, at least in pockets, to this critical mass being achieved.

And so we said, "Let's make it the top priority." And "What would we change if it's the top priority? How would MSN change? How would our browser strategy change? How would our server strategy change? What new groups, like Merchant Server, would be put together?" So that was a pretty big shift.

Now our employees, because they'd been out surfing the Net, were pretty much in tune with what needed to be done. So a lot of good ideas came along, and it took only a month or so before we had an internal plan. And then December '95 was when we articulated to the world all the steps we were going to take during '96, which we were able to execute better than I would have expected. The Internet is still full of surprises. It's

ILLUSTRATION BY JANET WOOLLEY

not as if you say, "Okay, we're done with the Internet."

The Internet is the place where all the neat new things are happening, whether it's multicast, better video compression, security technologies, 3-D browsing, personalization servers, server development, or site tracking. Anyway, there's more to be done on the Internet than has been done to date.

The success of Windows NT, the success of Office, the success of Windows 95: Those give us a good basis to build on because our strategy is to integrate Internet functionality into those products whenever possible, and that's a primary thrust. So when somebody buys a PC and wants to use the Internet, we want that built-in so they don't have to go out and try to integrate another piece of software.

PC: Is predicting when this stuff is going to happen getting easier or harder?

GATES: Well, as Microsoft has gotten larger we've gotten the ability to fund a pure R & D group. So we can have very risky products that you can't predict a date for.

Take voice recognition. If you go over to the lab, you'll meet some guys over there who think, "Hey, in two years—no problem." Now because it's their job, they're allowed to be optimistic. But in our business plans, you won't find that dependency written in. And we're willing to fund that work for however long it takes.

We have more luxury in being able to pursue a longer time horizon and therefore a more uncertain one. We can even have research projects that don't pan out.

PC: Windows was later than you thought; so was Windows 95. For years, you have talked about getting software on a more predictable schedule. Is that getting easier to do? Obviously, you can do things like deliver pieces over the Internet now. Is that getting easier? Harder?

GATES: I think there are groups like the Windows NT group that have been delivering on a very predictable schedule. It always depends on whether you set the schedule as the key thing or whether you pick a very ambitious set of features. In that case, you're going to need to take the time to do the beta test. During that beta test, you might hear about some additions or improvements that are worth making.

Nowadays, it's pretty nice because we have two ways of getting products out. One is to get them out on the Internet in a component-by-component-type fashion. And then the other is to take all those advances, really test them as a full system, get the user interface to be nicely integrated, go out to developers and explain how that's going to be out there in very large numbers, and then make a very large release. Windows NT 4 was very much like that. We have upcoming versions of Windows that'll be like that as well. So you really get the best of both worlds.

> "We have more luxury in being able to pursue a longer-term horizon and a more uncertain one."

COMING OF CAIRO

PC: A while back, you talked about an object-oriented system that you called Cairo, and at one point it was going to be a product. Now it's a set of technologies, some of which are here, some of which aren't. The overall combination seems as if it's a long way off. Is it still a goal?

GATES: Almost all of it is here today. And like all good things in technology, people take it for granted.

Object orientation is in the system. You can put an object of any type in a Word document or an Excel spreadsheet. The standards for how you do that are very straightforward. Eight years ago, we were talking about how that was going to be a very tough thing, and now it's just the way software is developed. It's components that fit into containers, and it makes things very extensible.

We've come up with features such as the Microsoft Foundation Classes, which make it quite easy for programmers to do those things. For Visual Basic programmers, they just take it for granted that if they want to do a Rich Form, they can go to a third party and get a control and embed that control into a form. The reason that works is object orientation.

The only thing out of all that vision that's not in the marketplace is the rich file/system directory combination that is now part of the NT 5 product. We actually put a developers' release of that into people's hands in November in a professional developers' conference we had. Later this year, that'll go into beta testing.

Having the rich storage system with the directory—that was part of that Cairo vision. Although a lot of the Cairo things have been done, that's the one that we're still working on. Today, when you think about storage, you think about storing messages as one thing or addresses as another thing or user objects and machine objects as still another thing. Anyway, there are just too many ways that people are storing things and having to learn utilities, different security, different replication, different enumeration, query....

There are two grand unifications taking place: All the presentation is being unified around a sort of super browser that takes over the shell, and then all the storage is being unified around a sort of super file system that takes over a lot of those functions. The storage unification is the harder of the two, but they're both very important and will make the system more powerful and easier to work with.

WINDOWS APIs

PC: You look at Windows today and Windows is now available in various flavors from CE up to NT Server and in various kinds of devices. Are there limits as to how far you can adapt Windows? At some point, do you need to transition to a completely new set of APIs?

GATES: NT is the only from-scratch commercial operating system that's been done in the last decade, and it was done based on the latest ideas of how you make things multiprocessor and very extensible. We put more money into advancing NT than is put into any operating system, whether it's MVS or all the different flavors of Unix put together. That's a very fresh piece of technology, and this year it'll get things such as clustering and 64-bit.

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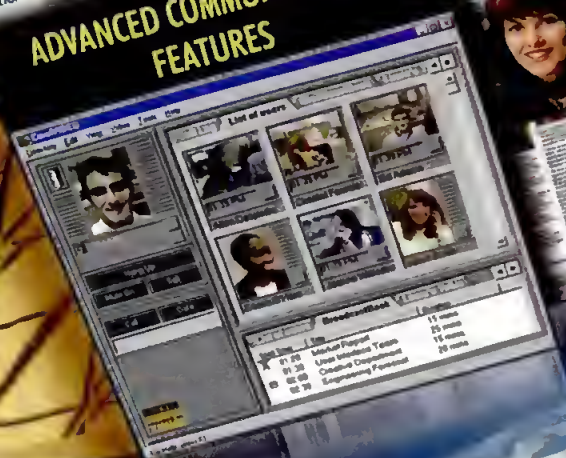
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The question of whether PCs can take on the toughest computing tasks will be answered once and for all. People still see Unix as being higher-end or mainframes as being higher-end, but this is the year when the pieces fall into place in both hardware and software advances. NT will be the foundation for the next decade. It's a very flexible base to be building on.

Over time, a lot of the operating system will become visual recognition and speech recognition; actually, the logic representing those very advanced input systems will be even more complex than what you think of the operating system being today. You'll still have that operating system there. In fact, it will be even better than what we have now, but this whole new element will come into focus on the kind of adaptation that's necessary for the rich input systems.

THE NEED FOR SPEED

PC: Machines are getting faster and faster. You have competitors pushing the idea that with the Internet and other types of networks you won't need all that new processing power and all the operating-system complexity. Yet if you look at the processor road map you'll see that we're going to have a fair amount of processing power. There are no signs of that slowing any time soon. Do we need the processing power that's going to be there?

GATES: I think the biggest use of processing power will be speech recognition, speech synthesis, visual recognition, handwriting recognition, and pattern recognition—that is, noticing what you're interested in and learning from that.

Those are all very deep problems where more RAM and more MIPS make a lot of difference. In the near term, just moving up to having MPEG2, 3-D graphics, better video—those will help a lot.

Just one point about complexity: There's a pretty important change coming this year when we allow you with the PC to keep software up on the server, but from a performance point of view it will actually get pulled down onto your disk. It's part of this Zero Administration Windows thing.

Anyway, that's just one of many simplifications that we'll be going through. Although underneath, the PC is going to have a lot of code working on your behalf, we can hide the complexity. There's a lot of stuff you see in the file system that you shouldn't have to worry about.

But processing cycles are going to be there. The question is how creative we can be about taking advantage of them. That's a question for the whole industry.

TOP TEN TECHNOLOGIES

PC: As part of this issue, one of the things we're doing is picking ten technologies we think will have the biggest impact on the industry in the next 15 years. What would you say are the technologies you expect to have the most impact over the next 15 years?

GATES: Speech recognition, natural-language understanding, automatic learning, flat-screen displays, optic fiber, the continuation of Moore's Law. Those are the key ones.

PC: Fifteen years from now, will there still be a concept of the PC? Or will PC technology be in so many different devices that people won't even think about it?

GATES: We'll certainly have a device with a large enough screen that you sit down and read information from and create information on.

Now anywhere you go, if you find a screen you can just log in and your personal environment will be there. If you're in a waiting room in an office, they've got a little flat screen there you can just pick up, log on to, and use. You won't necessarily always have to take hardware with you, because the network will retain the things that you care about.

Computing will be ubiquitous. You'll have the pocket device and the wall-size device, and (depending on how you set things up) you'll be able to talk to the computer when you're not really paying attention to it. So the term *PC* will call up a different image than it does now. But what you thought of 15 years ago when you said the term *PC* and what you think of now are vastly different. These sleek little notebooks with so much power that people carry around are just so radically different from the Compaq sewing machine that's less than 15 years old.

EXCITEMENT FROM SOFTWARE

PC: One last thing. In that very first interview in the first issue of *PC Magazine*, you talked about how personally excited you get when you complete a project. Do you still get that excited from software, or have you done so many programs now that it's not quite the same thing?

GATES: I think my job is more interesting now than ever because of the incredible impact that PCs are having. Whether it's empowering people or letting them communicate in a new way—the big-change element in business, entertainment, education—the PC, connected up to the Internet, is thriving on all that. It's very exciting.

In terms of actual product creation, we pick exactly the people who love creating these products, building them, and listening to the customers. I'm at a different level of management where I just get to feed in some ideas, give some feedback, and help make sure that what the groups are doing is very complementary. So I get a little bit of pleasure out of the broad range of products we're doing.

I do envy, sometimes, the people who get to come in every day and just work on a product, craft that product, and make it great. I can see that kind of excitement. And that's the excitement that leads to the very best work. It's where people push their limits and come up with new ideas.

So my job is to create a place where it's really fun and really easy to come in and do that. I get a lot of pleasure out of sitting down with these groups. That's why I make sure the majority of my time is spent with product groups. That's what I like, and that's where I think I can make a contribution. So the fun is still there, and software creation is still as much a mix of artistry and science as it has ever been. □

> "Software creation is still as much a mix of artistry and science as it has ever been."

INTERVIEW

GORDON MOORE, INTEL



PC: While you were still working at Fairchild Semiconductor, you wrote a paper in which "Moore's Law" was mentioned. Of course, you didn't call it Moore's Law at that point.

MOORE: No, certainly not.

PC: But you were talking about the doubling of transistors at a predictable rate.

MOORE: Every year, at that point.

PC: Later, it became once every 18 months.

MOORE: Well, I really said every two years. That was the fairly early days of integrated circuits. The most complicated chip around was still a laboratory model at Fairchild at that time, which had about 60 components; that was transistors plus resistors there. I was writing an article for the 35th anniversary edition of another magazine—*Electronics*—and they wanted me to predict the future of semiconductor components for the next ten years. And I was convinced the integrated circuit was going to be important, because you could begin to see this real impact on lowering the cost, so I looked back. We'd been about doubling every year since the first planar transistor—I call that Year Zero, 1959—with 1 transistor. We'd gotten up to 64 in six years—in 1965—so I said, "Aha, it's been doubling every year." I just said, "Okay, it's going to continue to do that for ten years."

So I extrapolated a factor of a thousandfold increase in the complexity of circuits, not expecting any real accuracy but wanting to get this idea of the way the components were going to be used. For that ten years, we followed that doubling every year really quite precisely.

Somebody else dubbed it Moore's Law. I think it was Carver Mead from Cal Tech. He tends to do things like that.

FOUNDING INTEL

PC: You and Robert Noyce left Fairchild in '68 to found Intel. What did you want Intel to be back then?

MOORE: We thought we saw in semiconductor memory an opportunity to build a general-purpose function of essentially arbitrary complexity that could shoot at a fairly big established market, replacing cores in particular.

And we chose new technology that we thought would be specifically appropriate for memory. Actually, I called this our "Goldilocks" strategy, in retrospect. We chose three technologies. One was a Schottky bipolar technology, and our first product was actually a 64-bit Schottky bipolar memory. We chose silicon-gate MOS. Up to that time, silicon gate had been demonstrated in individual devices, but it had never been put into production, and it had a lot of attractive features. And then we were going to make a multichip assembly of these things, so we could pack a lot of memory into a small area.

> "We're getting down to the point where the subatomic nature of matter starts to be a real limit."

It's the Goldilocks strategy because it turns out that the bipolar was too easy—it worked so well that it was easy for the established companies to copy it. There weren't any tough technological problems, so we didn't have a long-term advantage there. The multichip thing was too hard—we still don't do it, at least not cost-effectively. But the silicon gate was just right. While we were focused on it, we put all of our energy into solving the few really tough technical problems to make it a production technology.

So we had a long time there where we had an opportunity to expand in what turns out to be the mainstream of the technology, without much direct competition. It worked out just right.

Also at that time, after we got the first few memory products out, we did this calculator project where we changed the design from a bunch of custom circuits—which we couldn't begin to handle with our limited engineering resources—to the idea of a microprocessor (Ted Hoff's suggestion). And we saw we could do a lot of other things too.

MICROPROCESSORS

PC: When the microprocessor started to get used in personal computers (1975 and then on out), did you have any idea of how prevalent these things would be?

MOORE: Certainly I didn't, and if anybody else around here did they kept it to themselves. You know the first MITS—I guess you'd call it a PC now—the Altair; it was just a hobby device where the inputs were toggle switches and the outputs were LEDs. You could demonstrate the way a computer worked, but it was a tough way to do any practical computing. And I even turned down the idea of a home computer in that time period. One of our engineers



came up with the idea that you could build a computer and you could put it in the home, and I kind of asked him what it was good for, and the only application I got back was that the housewife could put her recipes on it. I could imagine my wife sitting there with a computer by the stove! It didn't really look very practical.

In fact, even when Steve Jobs came over and showed us what was going on at Apple, you know, I viewed it as just one more of the hundreds of applications that existed for microprocessors; I didn't appreciate that it was a significant new direction.

PC: Go on another three years or so: It's 1980. IBM is around and looking for a microprocessor for what would become the PC, and obviously you guys sold IBM the 8088. How important was that sale?

MOORE: That was a period of time when we were competing very strongly with Motorola for design wins. Motorola had a good part out on the market, and we were

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concerned that this company was going to run away with a whole generation of designs. So we put together a very aggressive marketing program, where we wanted to get 2,000 design wins. I think it was in the '79–'80 time period, over something like a year span, and we went aggressively out to pitch every design we could.

Well, one of those designs happened to be the IBM PC. In fact, the salesman who was calling on the account wasn't even told what the project was; it was, you know, cover the conference room with a blanket in between and ask questions. You would answer the questions but never see what the product being worked on was. Of course, eventually we found out it was the PC. But even IBM expected only to sell a few hundred thousand of them over the lifetime of the product. And while we thought it was a significant design win, it was one of something like 3,000 that we had in that time. I certainly didn't realize that it was going to be the future of Intel, even when the IBM PC got announced.

> "I see the physical limits of chip design focusing more innovation in other directions."

PROCESSOR CHANGES

PC: In the late eighties, early nineties, there was a lot of talk about RISC processors. You developed a few RISC processors too—the 860, the 960. Were you worried that the *x*86 processor was sort of older technology and that this was going to surpass it somehow?

MOORE: You know, we considered it principally marketing hype, but that was a tough sell, trying to convince people that RISC was marketing, not technology.

There were some things you could recognize. Clearly, if you threw everything away and started with a clean sheet of paper again, which was what the RISC people got to do, you could avoid making some of the mistakes that were done in some of the early architectures: putting in more registers, making all the instructions the same length, things like that. But we had this tremendous advantage: all of the software people had bought that ran on our instruction set. We were convinced that was a very important advantage.

Everything that came along (except throwing away some of the warts on the existing architecture) we could take advantage of. We could make superscalars; we could pipeline; we could do all of these things that were getting the performance. It may have cost us some more transistors, but as long as we had a far higher unit volume than any of the RISC processors, we could afford to put more transistors in to maintain the compatibility.

PC: Basically, since the 386, the architecture of the basic chip hasn't changed that much. The instruction set, until MMX, didn't change at all.

MOORE: The instruction set has stayed the same, but we've added a lot of other things. The 486 put the floating point on there. All the pipelining and superscalar and that kind of stuff has come on. We call that part of the architecture, even though the instruction set stays the same. MMX, of course, is a change in that.

PC: Now you're talking about VLIW and 64-bit stuff.

MOORE: We're not talking about that at all. I mean, we're doing a 64-bit program, but we're not describing what it is.

PC: Does the instruction set have to change?

MOORE: Sure, 64 bits means new instructions. But it will still run the older software compatibly. You know, one thing we have is the idea of carrying a compatible family along. Even if we have to put two processors on the chip, one 32-bit and one 64-bit, it's going to run that old software effectively.

MANUFACTURING LIMITS

PC: Let's talk about manufacturing. When you do the Moore's Law charts, you have all of this wonderful doubling every 18 months or so. How long do you see that going on?

MOORE: Actually, there's still quite a bit we can squeeze out of the technology, and I'm amazed at how effectively people have been able to continue spinning the next versions. There's kind of been a generation of technology every three years, where essentially we double the density every three years. The minimum dimension multiplies by about 0.7, and 0.7 squared is 0.49; you get the same thing in half the area. And now, for Intel, our leading production technology is 0.35-micron, and 0.25 is moving into production as soon as we can get it cleaned up. That'll be the workhorse in a couple of years. And that's still straight optical lithography. 0.18, which is kind of the next step, looks as if it can be done optically without any dramatic changes in what we're doing.

The step after that to me looks a little tougher, but the guys who have to do it don't seem to be intimidated by it at the moment. The reason is that we'll probably do it with the so-called 193-nanometer light source—the excimer laser—and do 0.18 with that. The wavelength and the minimum dimension are about the same optically; that's not too bad.

To do 0.13 in the 193 is a much tougher deal, because you're operating quite a bit below the wavelength. So you probably have to do all of the tricks available—you know, phase shift masks and this kind of stuff, multilayer resists—the ideas that exist in the industry but are not a lot of fun. You know, they're not that well developed yet, so there may be another light source that lets us operate at a shorter wavelength.

The trouble is, if you go to a shorter wavelength, you essentially run out of transparent materials, so all the optics have to be reflecting.

Beyond that, I guess when we get to an all-reflective system we can go quite a bit further. But we make a change from the kind of lithography we've been doing for the last dozen years when we abandon transparent optical materials. That's a change, and it's going to be an expensive change at least. Then you eventually get to some kind of a physical limit, and the industry has argued about where that is for some time. I think the consensus is it's

someplace between 0.05 and 0.1 microns minimum dimension, and like most of these limits it keeps pushing further away as we get closer.

We're getting down to the point essentially where the atomic nature of matter starts to be a real limit when you get down there. That's a fairly fundamental limit. So that carries us well into the next century. At that time we'll be able to put, I don't know, several hundred million or a billion transistors on a logic chip. That leaves phenomenal room for the designers to innovate in how they're going to use those, so I don't see this as being the stopping of innovation in the industry or anything. I just see it focusing more innovation in other directions, so things will advance for a long time.

> "Voice recognition will open computing to the 85 percent of people who are nonparticipants today."

FUTURE TECHNOLOGY

PC: On the design end, a lot of people talk about a lot of very different kinds of ways of making semiconductors, whether gallium arsenide or multistate logic. Which, if any, do you think are really important?

MOORE: Well, somebody once said, "Gallium arsenide is the material of the future and always will be." I spent a lot of money on gallium arsenide in the sixties and got convinced it was a fairly intractable material. It's neat for the front end of cellular phones when you want a little bit of stuff that's high-performance, but it's not going to compete in the mainstream. You know, we now do everything on 8-inch wafers—nobody has seen an 8-inch wafer of gallium arsenide. We'll be at 12-inch wafers probably by the end of the century. People can't grow crystals that big in any of these other materials! So I think the mainstream is likely to be silicon-based forever.

PC: There's a lot of talk about optoelectric chips, using light more, and holographic memory.

MOORE: I am not a real believer in optoelectronic chips to do computing. But it's interesting for communications applications.

PC: Holographic memory?

MOORE: Holography memory? I'm not close enough to that. The densities people talk about being able to achieve are phenomenal: a lot of information storage. It's capable presumably of giving one of those real qualitative leaps in the amount of stuff that's available. Something may come of that. I'm not close enough. On the other hand, the ability of the magnetic-disk people to continue to increase the density is flabbergasting; that has moved at least as fast as the semiconductor complexity. You can get a 2.5-gig drive for 200-and-some bucks now down at Fry's [the Bay Area electronics-superstore chain]! It's absurd!

PC: What about some of the quantum computing ideas?

MOORE: The quantum computing—that's a hot new one. Again, this is getting further and further away from my area of expertise. I think quantum computing is a very interesting concept. I think it has no practical application whatsoever.

CHIPS IN 15 YEARS

PC: You talked about the "2011" chip.

MOORE: Oh, yeah, that was Andy [Grove]. He gave a view of that at Comdex, and I wouldn't want to take credit for any of that. [Joking:] I think somebody got carried away with his semi-log paper. They were very aggressive extrapolations.

PC: So you think a 10-gigahertz chip with a billion transistors on a 0.07-micron process is. . . .

MOORE: By 2011, that's asking for everything to fall in line perfectly. A 10-gigahertz chip of that complexity, to keep the power in anything reasonable and tractable, is really tough. The power thing really becomes a problem, and I consider that one of our biggest challenges, particularly for laptop systems and cheap desktop systems. The power wants to go up to hundreds of watts as you go in this direction (probably thousands of watts if we go that far), and there aren't simple systems for taking that kind of power out.

I start to understand why the mainframe people used to circulate Freon and water-cooled and the like. You really are pushing the power as hard as you can, and I think that's going to limit these combinations.

PC: One way or another, 15 years from now we're going to have really powerful chips compared with what we've got now, right?

MOORE: Yeah, I'll admit that.

PC: What do you think we're going to be doing?

MOORE [laughing]: That's harder to answer. I think there are some things that are very attractive. You know the one I always come back to is good voice recognition. I really think a computer you can talk to—it can understand your speech, not only the words but also the meaning—is going to change the way computing is done, and I think that is the role that is well worth shooting for.

That's the kind of thing that is going to open up computing to the 85 percent of the people who are nonparticipants today. That requires a lot of processing and a lot of memory, but I really think it's going to be an attractive deal. You can ask your computer to go out on the Net and get you some information. Like, I would ask my technical assistant to go out and get me the data on such-and-such and have the computer come back with it. I think that's fantastic, and I think it's doable.

PC: What about you? You had joked about retiring. Are you going to retire, are you here forever, or are you going to do what Bob Noyce did with Sematech after he left?

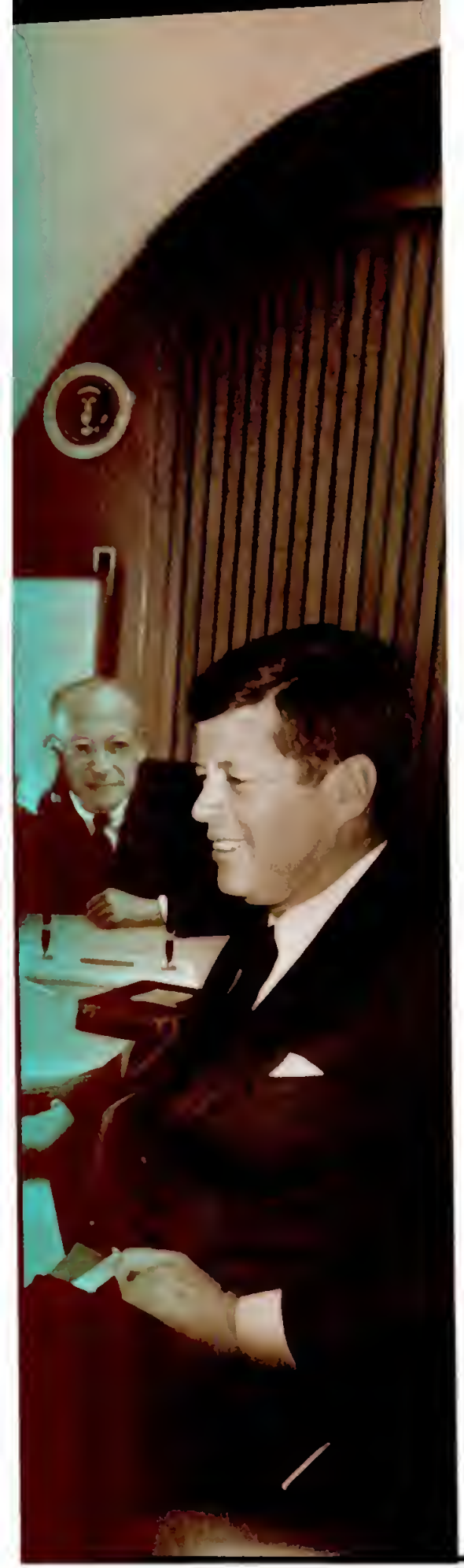
MOORE: The last one: Heavens, no! I guess I'm semiretired now; I'm a three-day-a-weeker. But I can still keep up with a lot of the stuff that's going on—maintain my touch with the excitement in the industry—and boy, if the alternative is staying at home and taking out the garbage, I'm going to stick around here for a long time. □

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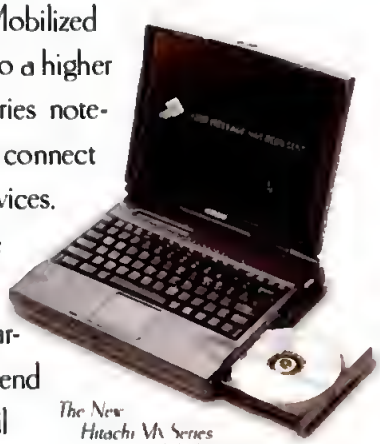
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The More Things Change

Nine veterans share their views on the future of programming.

Edited by Sharon Terdeman

Nearly everything about programming has changed in the past 15 years—the operating environments, the languages, the paradigms, and the systems themselves. But some factors seem to remain constant: the struggle for cross-platform compatibility, the search for the ideal language, and above all, the complexity involved in producing robust, feature-rich, user-friendly software.

The truth is, the easier programs are to use, the more complexity is usually hidden under the hood. And if history teaches us anything, it's that there is no magic bullet to change this. Just ask any veteran programmer. We in fact asked nine veterans to give us their uniquely informed perspectives on the future of programming and software development. Some are *PC Magazine* regulars and others are not, but all have been instrumental in shaping the industry. We're sure you'll find their visions both instructive and entertaining.

IN THIS SECTION

TUTOR Our exploration into the world of Visual C++ programming continues as we finally get our sample tic-tac-toe game program to draw X's and O's in the correct boxes on the game board. *Page 317.*

POWER PROGRAMMING Telnet has become one of the more important protocols on the Internet, especially for letting Webmasters manage their sites. This time we explain the protocol and show you how to program a 32-bit command line Windows 95 telnet client. *Page 333.*

INTERNET TOOLS Traditionally, the simplest way for Web servers to retrieve information from browsers has been to use CGI. Here, we discuss alternatives that offer more power through using Web server APIs. *Page 349.*

UTILITIES Are you sick of seeing the same old Windows logo on the background of clouds and blue sky when you start up your system? LogoMania, this issue's free utility, is the remedy for which you've been searching. It lets you choose your own image and animation for the start-up screen. *Page 355.*

ALSO IN THIS ISSUE In PC Solutions, we tell you how to dual-boot between Windows 95 and DOS, provide some useful information concerning the Windows 95 start-up disk, reveal how to delete OS/2 network files in order to save space, explain the compatibility problems with serial date numbers between Quattro Pro and WordPerfect, provide a couple tools that make it easier to manipulate the date in your Microsoft Access database, and more. *Page 361.*

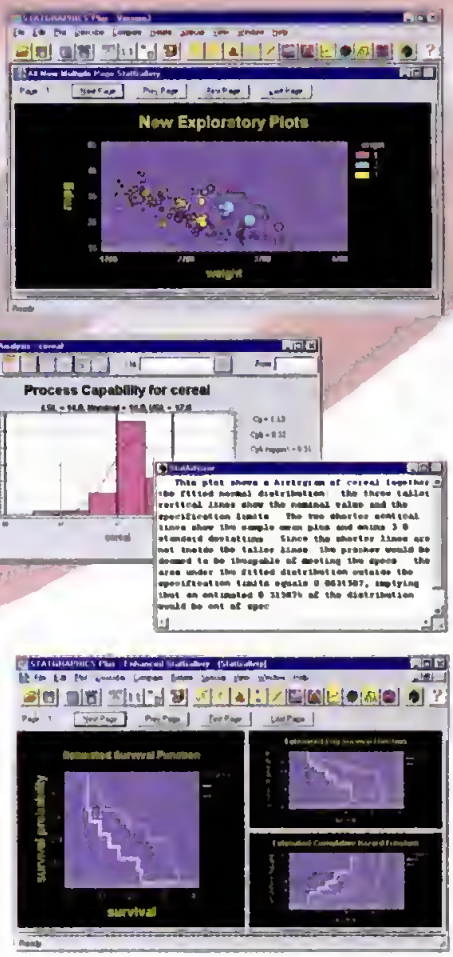
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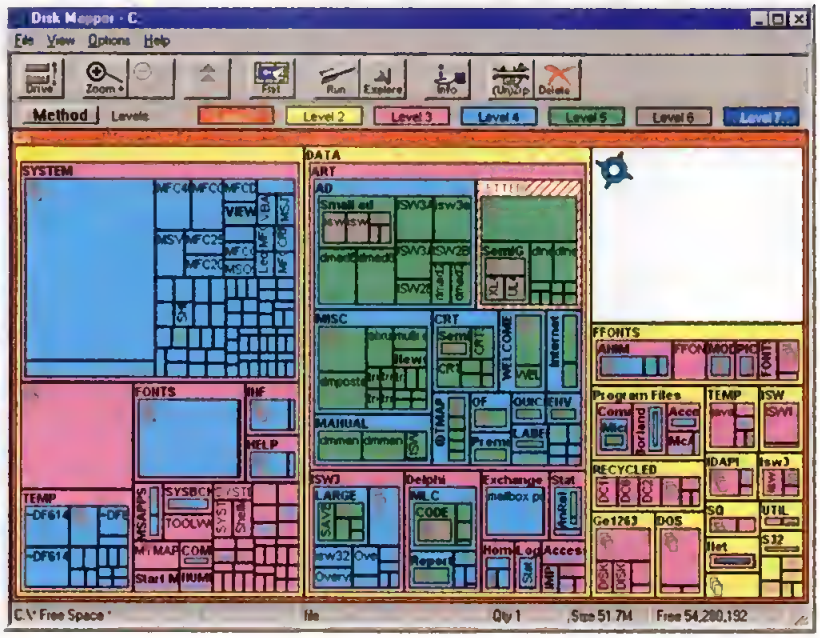
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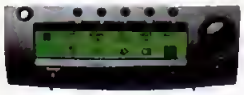
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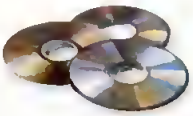
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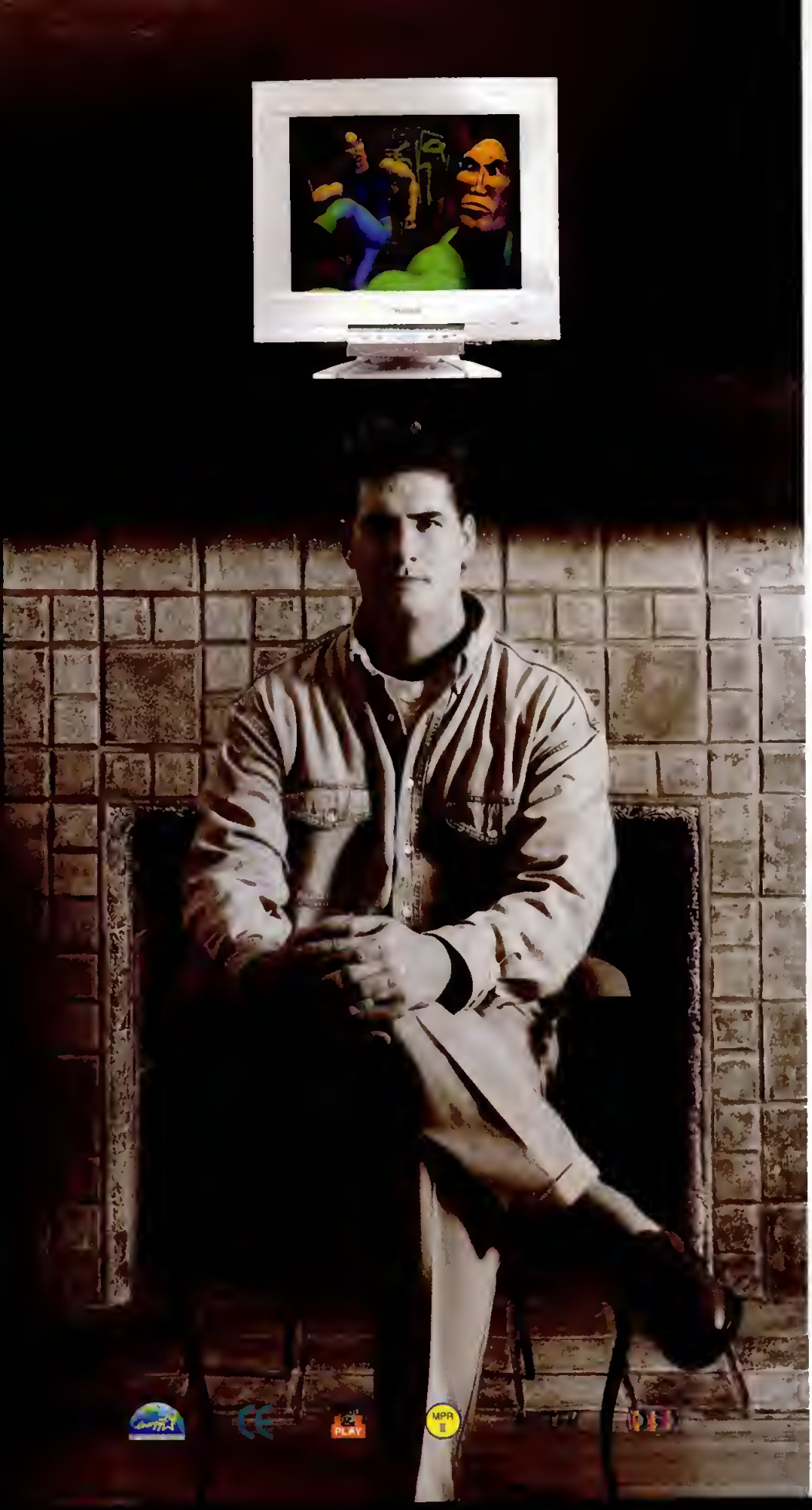
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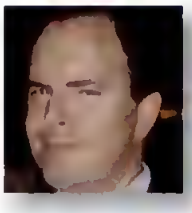
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Douglas Boling

Those who forget history are doomed to repeat it—or something like that. Whatever the case, to make any kind of guess at what the future holds for this chaotic industry, it helps to look at the past. Over the years, I've developed a few guidelines that seem to work when predicting the future of the personal computer industry. So instead of making specific predictions, I think it's better—and safer—to talk about the guidelines I use when attempting to understand what is going on in our little corner of the world.

• Over time, the PC industry always migrates to one standard platform. While folks love to talk about multiple platforms coexisting in harmony, software companies have a hard enough time developing for one platform, let alone two. Even when a company develops for more than one platform, one will be the original platform and the other the "ported to" platform; the product on the secondary platform will always lag behind the original in features and schedule.

"While folks love to talk about multiple platforms coexisting in harmony, software companies have a hard enough time developing for one platform."



• The speed of software is a hardware problem. This statement—heretical to hardware engineers—must be accepted along with Moore's law, which defines increases in computing speed. Software engineers are only being smart by anticipating and utilizing the power of next year's box when writing software this year. When Moore's law does not apply, however, this observation doesn't work. For example, programs need to be much smaller if they are ever going to be downloaded interactively from the Internet through a 33.6-Kbps modem.

• Never believe the pundits who tell you they know what programming language you will be using in two years. Remember when folks said the language everyone would be using would be Ada? After all, the government demanded it! What about the folks last year who pitched C++ as the language of the future? Have you noticed that they are the ones teaching Java classes this year?

• Users don't care about technology, only about solutions. I define users as "normal humans," not the techie, computer-literate power users programmers are tempted to develop for. 32-bit means nothing to users. Neither does multithreaded. Users care about features and speed. If using advanced techniques helps, great. Just don't expect users to like an application or operating system simply because it uses some advanced programming technique.

• The Intel 386 instruction set is the standard byte-code set for the personal computer industry. Why should anyone run off and write in some mythical Java byte-code set when most of the software ever written by humans is written in 386 (or 8086 subset) instructions? When someone says Java byte codes, think Esperanto.

Okay, that last point is more of a prediction than a guideline. I had to throw one in. The future of the PC industry looks bright. As the man says—enjoy the ride.

***Douglas Boling** is an electrical engineer, a contributing editor of* PC Magazine, *and the author of more than 30* PC Magazine *utilities. He started working with personal computers 20 years ago when he bought a KIM I microcomputer. Since then, Doug has owned and programmed many personal computers, including a Commodore PET, a Macintosh, and quite a few IBM PC compatibles. He lives and works in San Jose.*

Alan Cooper

The most difficult task facing the programmer in fin de siècle Silicon Valley isn't grokking the Web or coping with Microsoft—it's knowing how to create software that makes users happy and productive.

Programmers are skilled at using complex and difficult tools to create powerful programs. Unfortunately, many such programs also end up with complex and difficult user interfaces, and modern users don't have the time or inclination to learn to use them. And if the interface is too difficult to learn or use, all of that power isn't very effective, because the users can't apply it. A simpler interface offering fewer but more appropriate features is usually perceived by users as being more powerful. And if the simpler interface makes users more effective, then it really *is* more powerful, in practical effect.

Today, most software is built from a document variously called a feature specification, a marketing-requirements document, or a product spec. This document is a comprehensive list of the features the product must include. It frequently omits any discussion of how those features will be presented to the user. If the specification does mention the interface, it rarely goes beyond "style guide" requirements for conventional menus, toolbars, and dozens of forms, and it keeps to a strict one-dialog-per-function design attitude.

Typically, though software built from this sort of spec may get the job done, support costs are high, job dissatisfaction common, and the resultant staff turnover frequent. Such spec documents allow programmers to build programs, but they don't ensure that such products are usable, effective, or well liked.

The reason for this failure is that rather than being the result of a design process, the spec document is the result of a process that is just a *preliminary step* to the design process. When a community decides to build a hospital, for example, it hires an architectural firm. The first step the architects take is to create a list of the hospital's requirements: How many patients it must support and how many operating rooms; whether or not it needs special facilities for emergency or intensive care. Only after this list has been carefully scrutinized by all parties does the *actual process* of architectural design begin; the requirements list is a source document for this process, not its end result.

By contrast, in the world of software development, the requirements—or spec—document isn't treated as input to the design process but as the ultimate output! It is as though the building contractors were handed a typed list reading "120 beds, 3 operating rooms, emergency care," and told to build a hospital the community could be proud of. To their credit, programmers work wonders with what they are given, but the next few years will see a general dissatisfaction with such contractor-designed software.

"A simpler interface offering fewer but more appropriate features is usually perceived by the user as being more powerful."



In the future, instead of a feature-specification list, the central document will be a design-specification document created by professional software designers. The software design spec will explicitly describe what the program is supposed to accomplish, for whom, and how. The most important parts of the spec, however, will be the ones that exhaustively describe exactly what the program does, and how the user

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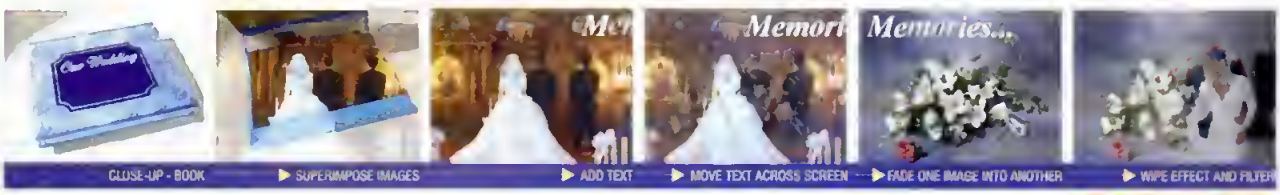
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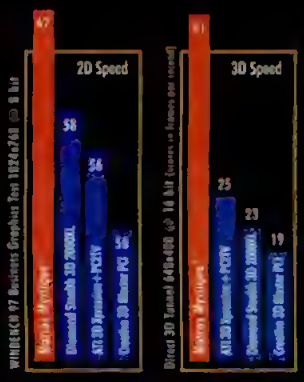
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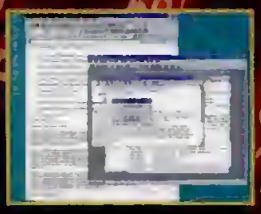
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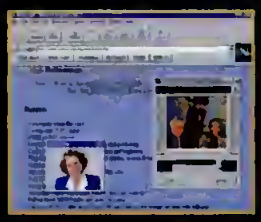
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commands it. Not only will the visual aspect of the interface be described, the actual interaction will be shown. If the user is to select a particular object, the spec will describe exactly how that object will look on-screen and exactly how it will behave when the user clicks on it and drags it. The spec will describe how the program's features, the user's actions, and the consequences of those actions will be communicated to the user.

The biggest difference, however, wouldn't be in what is *in* the document but in the process used to create it. Software has historically been built only from exhaustive and detailed lists of required features; interfaces have reflected this by being characteristically exhaustive and detailed. The interface mirrors how the program is built. I call this type of design the "implementation model." Unfortunately, implementation-model programs force users to understand how the program was implemented in order to use it. Instead of allowing users to specify their goals, the program demands that the user tell the software *how* to achieve them.

Unlike the implementation model, the in-depth software-design process ignores details of implementation until the final stages of the process. Instead, it spends much of its time focusing on who the users are and what their goals are. The process then concentrates on delivering the users' goals in the most direct manner possible.

Goal-directed designs are easy to spot, because they rarely have more than two screens or views. After all, users rarely want to achieve more than two goals with a given software product. Dozens or even hundreds of tasks may be involved in achieving those goals, but if the interface is shaped by the tasks rather than the goals, the design immediately becomes implementation model: It becomes feature-centric. Users would be perfectly happy if all of those tasks went away, and the program just allowed the direct achievement of goals. The modern software-design process makes clear which parts of the interface are tasks and which are goals, allowing the designer to push tasks into the background and to express the interface in terms of the users' goals.

The explosion of the Web illustrates how effective goal-directed design can be. From a features point of view, the Web is weak compared with a spreadsheet or a corporate invoice program. But compare those programs' popularity with the Web's. The Web may be weak, but it allows users to achieve the goals of finding information and communicating with others without having to understand how the software works or having to learn obscure commands and features.

As Web software and desktop software merge, the need for modern, goal-directed software design will increase dramatically, and users won't be the only beneficiaries. Programmers will be happier, because they can concentrate on mastering the awesome complexity and sophistication of modern computer systems, and software designers will smile as they concentrate on mastering the awesome self-centeredness and irrationality of modern users. Working as a team, programmers and designers will make users happier and more productive by becoming happier and more productive themselves.

***Alan Cooper** is best known as the father of Visual Basic and the author of* About Face: The Essentials of User Interface Design *(IDG Books, 1995). Alan developed goal-directed design, which Cooper Software, his design consulting company, uses exclusively. You can contact him via e-mail at* alan@cooper.com *or through the Web at* www.cooper.com.

James Gosling

Imagine a world where all programmers use a common set of tools to create applications. The programmers write all sorts of applications, from those that run a car's fuel injection to those that automatically shut off an iron. The applications can execute virtually any task, and are as varied as we can imagine. They can run on any device with a CPU and can be written from a programmer's platform of choice. But these applications share a common element: the building blocks upon which they are founded.

In this world, knowledge would be modular. A programmer who writes applications to conduct commerce over the Internet could also write the code that makes a watch able to display all of the world's time zones.

> "Imagine a world where every electronic device on
>
> 
>
> the planet can communicate with every other one, where the technologies we use are totally integrated."

Write once, run anywhere goes beyond the modularity of Java and its ability to run on any platform. It translates into a world where programmers learn once, write anywhere. It brings continuity to programming in a way that was previously nonexistent. Write once, run anywhere certainly does not eliminate specialization, but it does make knowledge cumulative. Programmers could build on what they know instead of having to retrain with every iteration of the latest technology.

Such a concept also means that all the technology in our lives can be interconnected. Every electronic device on the planet can communicate with every other one. Imagine a world where the technologies we use are totally integrated, where your coffee machine brews a cup of coffee between meetings by communicating with your calendar so that you can drink it fresh and piping hot, right on time.

Java will be the great equalizer of platforms. It will be the bridge connecting Wintel, Mac, and Unix. Users and programmers alike will have the luxury of using their platform of choice—a luxury indeed in today's world, when standardization seems to be the mandate.

As I look to the future, I see a world of total integration. The very nature of programming will change. The network computer and smart cards are merely harbingers of the things to come.

***James Gosling** is vice president and a Sun Fellow of Sun Microsystems, and the lead engineer and key architect behind Sun's new Java programming language. James has been involved in distributed computing since his arrival at Sun in 1984. Before joining Sun, he built a multiprocessor version of Unix as well as the original Unix Emacs.*

John Lam

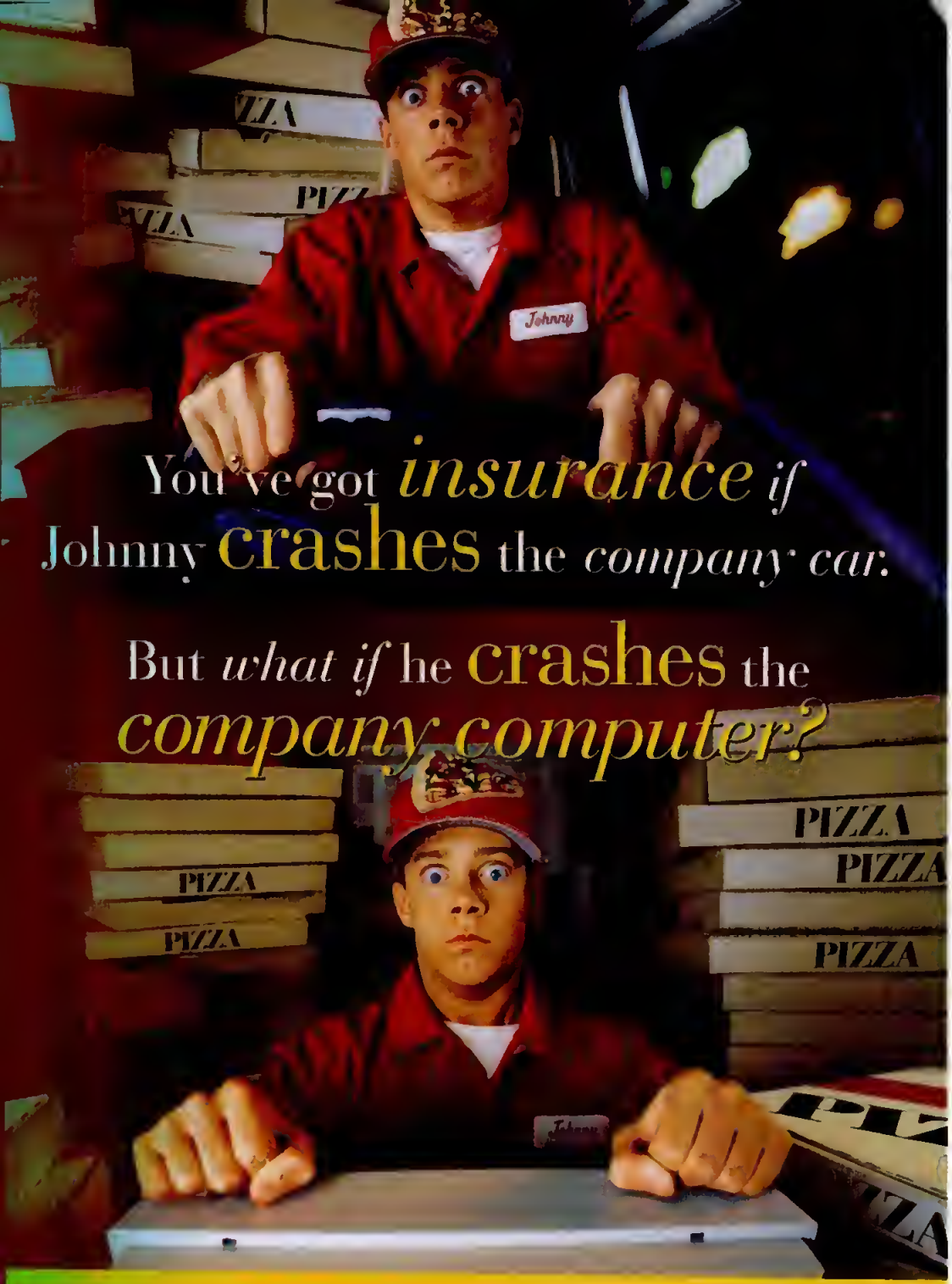
The one constant in the software industry is the search for the "killer tool" that will dramatically improve productivity and lift the huddled programming masses into the heavens. Yet we have all seen many a killer tool come and go. The ones that remain are those that can deliver real benefits to both developers and their customers.

The latest killer tool in our industry is Java. If you believe the hype, Java will sweep aside our cross-platform programming problems and allow us to run a single executable file on all of the computers in the known universe. But don't believe the hype; history can be a great teacher.

The dream of cross-platform programming is not new. The C programming language rapidly became the standard language for computers everywhere. Yet it failed to reach the mainstream as a cross-platform programming language. Why?

With the advent of graphical user interfaces, the majority of modern programs spend most of their time talking to their computer's operating system. This minimizes the benefit of a cross-platform language, because the real complexity of a program lies within its interactions with the operating system.

Can Java solve this problem? Whereas C was reasonably portable at the source-code



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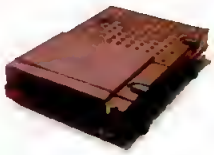
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level, Java is designed to be portable at the executable-file level. Java uses native class libraries for each target operating system so that the same executable file can inherit the look and feel of different operating systems. Sounds good. But what's wrong with this approach?

Java attempts to homogenize all GUIs. Users, however, are demanding much more these days. A Windows 95 user has come to expect a certain look and feel from applications. A warmed-over Mac application that uses Windows 95 user interface widgets simply does not feel like a native Windows 95 application. Therefore, the application fails to deliver value to the customer.

Companies must remain focused on delivering value to their customers. Cross-platform programming promises to minimize R & D expenditures, but at the risk of potentially alienating their customers. Remember what happened to Multiplan, Microsoft's cross-platform spreadsheet of the early 1980s? It was eliminated by a blazingly fast spreadsheet that was specifically optimized for the IBM PC environment—Lotus 1-2-3.

"We've all seen many a 'killer tool' come and go.



The ones that remain are those that can deliver real benefits to both developers and their customers."

Don't misunderstand me here. Java is a great programming language. It was designed with a clean slate, and it is far better suited for event-driven programming than languages like C++. But let's give up on the cross-platform Holy Grail. Your users deserve more than that.

***John Lam** is president of Naleco Research* (www.naleco.com), *developers of RADFind 96, a high-speed file-finder utility for Windows 95. John has been involved in software development since the good old days, when he was writing applications using a line-oriented mini-assembler for the 6502. His primary interests are in the design and implementation of COM-based solutions to difficult systems programming problems. John, who holds a doctorate in organic chemistry from the University of Toronto, speaks annually at the Borland Developers' Conference and actively participates in the local software development community in Toronto.*

Gordon Letwin

Software development for personal computers began when RAM capacities reached the awesome 4K mark. A few rich folks had 8K. Back then, the hallmark of software development was "watchmaking craftsmanship"—making your code as dense and efficient as possible. We knew what to write: versions of big machine software, such as compilers and editors. The challenge was to write them smaller than ever before.

As hardware capacity increased, the emphasis changed from being able to do it at all to doing it with panache. Engineers were happy with a simple outline for a screen window, but the general public wanted cool incised-looking boxes, with proportional fonts and color.

"Programmers are not immune to fads; every few



years, a new fad is born that will solve the 'software crisis' and, most likely, bring world peace."

At roughly the same time, software design moved into unknown territory, doing things that had never been done on the big iron: image editing, integrated development environments, groupware, multimedia, and so forth. The Internet, though not new, is being used in ways that are. The emphasis for software engineering has moved from craftsmanship to imagination.

The amazing number of applications for and uses of PCs has had a major impact on the development of system software—operating systems, GUIs, and so on. Today, it requires billions of dollars to engineer and manufacture a state-of-the-art CPU; likewise, it requires a massive investment to produce a state-of-the-art operating environment that is compatible with the PC standard. At one time a team of a dozen could produce a version of DOS, and another team of a dozen could produce a compiler. Today, it may take 50 people to produce a compiler and 500 to produce a new OS. The majority of that effort goes into preserving compatibility with the standard—a standard with no written definition. The software business is no more restricted to entry than the chip business is; there's always room for new ideas. But the OS part of the business is no longer a game for start-ups.

As technical systems emerge, improvements increase the complexity of the system. As the systems mature, development effort is diverted from "more" to "easier." Today's automobile is much easier to operate than a Model-T—you turn the key and press on the gas. The driver knows nothing of starters, chokes, or engine mix, or even of clutches and transmissions. Computers will similarly reach a peak in user complexity, and they're probably near to that now. The earliest movements toward artificial-intelligence systems are already evident: automatic-hinting systems, user agents, help wizards, Internet search engines, and the like. Computer whizzes will continue to see the inner workings of their machines, just as race car drivers do. But for the general public, a computer will become more of an assistant than a simple tool, approaching the goal of a machine that figures out what you want and does it for you.

Predicting the far future of software development is easy: you just give the standard "all things to all people" speech. Predicting the immediate future is also easy: you just talk about what you're working on now. It's predicting the intermediate future that is hard. But I can offer three sure-fire intermediate future predictions:

- More failed attempts at creating an "all things for all people" environment. Typical of these projects is the pursuit of the "universal operating system" that runs applications written for several different platforms. These projects look good on paper but never succeed.
- More "fairy dust" solutions. Programmers are not immune to fads; every few years, a new fad is born that will solve—or so it is proclaimed—the "software crisis" and, most likely, bring world peace. Object-oriented programming was the previous fad; Java, the current one. Both of these are useful tools but neither will live up to a fraction of their hype.
- Lots of surprises. We are as of now not even halfway through the computer revolution. The rate of hardware improvement may slow somewhat, but the rate of impact on people's daily lives will accelerate. As the saying has it, "You ain't seen nothin' yet!"

***Gordon Letwin** joined Microsoft in 1978, when the company consisted of 12 people. He became the lead OS architect, developing Xenix and then serving as the chief architect of OS/2, Version 1.0. Gordon is currently on leave from Microsoft and is working on home-automation issues.*

Charles Petzold

In 1985, a visit from Microsoft bigwig Steve Ballmer to the offices of *PC Magazine* could mean only one thing: Another pre-release version of Windows was ready for our perusal. Those of us at the magazine who were interested in Windows (not many, actually) would gather in the office of Bill Machrone or John Dickinson to check it out.

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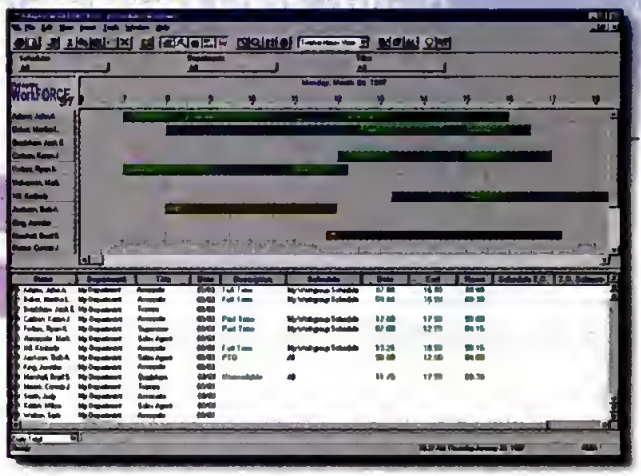
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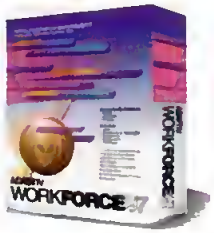
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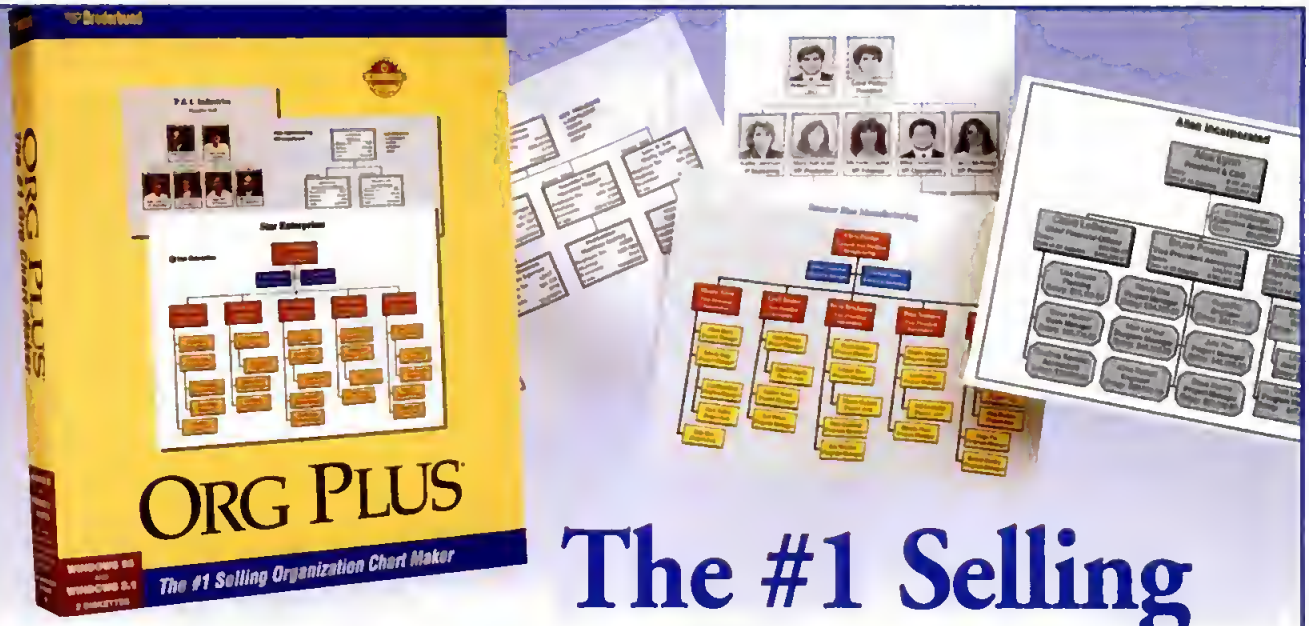
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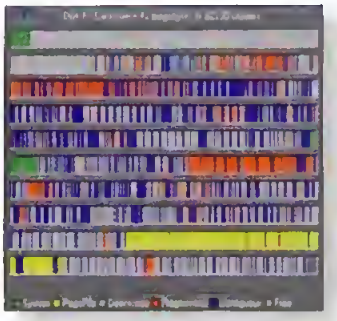
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They were two of the few people at the magazine who had EGA boards on their machines and could therefore run Windows in color.

Those prerelease versions of Windows were never quite stable enough for practical use. Crashes were frequent and hard. We'd play with each one for a while until we got bored, and then wait for the next visit from Ballmer. This continued until shortly before the official release of Windows 1.0, in November 1985.

Of course, Windows wasn't a success right away. By the time of its release, Windows even had some competition: *PC Magazine*'s February 25, 1986, cover story proclaimed "Window Wars!" as Windows faced off against Quarterdeck's DESQview, Digital Research's GEM Desktop, and IBM's TopView. And no one was placing bets on which windowing environment would eventually reign supreme.

"We're probably safe in assuming that the



Windows of the future won't veer too far from its origins. . . . The wimp interface lives."

Bill Gates had predicted that Windows would be a "slow burn." That proved to be truer than he probably would have preferred. Although many software companies had initially committed themselves to writing Windows applications, most of them (Microsoft included) weren't in any great rush actually to develop or release anything. Those of us at *PC Magazine* who understood the role of Windows as a platform for the next generation of PC applications had high hopes, but early Windows applications (with the exception of those from Micrografx) were simply awful.

That's why you won't find many reviews of Windows applications while perusing old issues of the magazine. Nor will you see much about Windows in the magazine's productivity section. In those early days, no one considered Windows to be a tool for power users; Windows was assumed to be an environment for naïve users who lacked the testosterone necessary for hard-core computing—that is, the same type of people who used Macs.

The great leap forward for Windows came in 1990. In May, Microsoft introduced Windows 3.0, widely perceived as the first version of Windows that was ready for prime time. Technically, the major difference between Windows 3.0 and its earlier versions was that Windows 3.0 exploited the protected-mode operation of the Intel 286 microprocessor, thus giving the environment access to 16MB of memory. But additional factors were at work to make Windows 3.0 a success, and a critical mass had finally been reached: Windows was finally robust enough, hardware finally fast enough, and applications finally plentiful enough for Windows to be a full-time environment for most users.

May 1990, also saw the launch of William S. Hall's Windows column, *PC Magazine*'s first effort to cover specifically Windows issues for power users. In 1990, two *PC Magazine* contributing editors who had had long experience with Windows programming (Ray Duncan and myself) would probably have been writing about Windows had it not been for the distraction of OS/2, the operating system created by IBM and Microsoft that was supposed to replace DOS and Windows, as well as eliminate poverty and war. No, not even Petzold and Duncan could save OS/2 from the marketing geniuses at IBM.

My Environments column debuted in September 1987 and, until February 1995, explored programming issues in OS/2, then Windows, then OS/2 again, and finally Windows again. They say you can recognize pioneers by the arrows in their backs. I have a few myself, mostly dating from the fall of 1991, when I embarked on a series of columns about what I felt (and still feel) to be one of the most important enhancements to Windows ever: multimedia.

At the time, CD-ROM drives were a luxury item, sound boards were for games, and multimedia extensions to Windows 3.0 were software add-ons. The Environments column covered the new sound and music support in Windows; reader ridicule followed. Of course, multimedia extensions were later incorporated into Windows 3.1 (released April 1992), and today, hardware multimedia support is built into most desktop PCs. Few people today care to remember how "unnecessary" such extravagances were considered just a few years ago.

Another important step for Windows was the move to a 32-bit architecture. Although the first 386-based PCs had been available since 1986, operating systems were slow to use the 32-bit processing available with these microprocessors. Industrial-strength 32-bit Windows (known as Windows NT) came out in 1993, and the more consumer-oriented 32-bit Windows 95 arrived two years later, leaving 16-bit programming forever behind.

Perhaps what is most impressive about Windows is how malleable it is—(picking up a decade's worth of features and running on everything from husky RISC-based workstations to tiny little palmtops. Throughout this process, Windows has retained an identity easily recognizable by both user and programmer.

For this reason, we're probably safe in assuming that the Windows of the future won't veer too far from its origins. Handwriting and voice recognition seem to be shelved for the time being, and no one has come up with anything better than Windows, icons, mice, and pull-downs. The wimp interface lives.

***Charles Petzold** has been a contributing editor of* PC Magazine *since 1985. He is the author of* Programming Windows *(Microsoft Press, 1996) and* OS/2 Presentation Manager Programming *(Ziff-Davis Press; out of print). He is currently working on a book for Microsoft Press on digital image processing for Windows.*

Matt Pietrek

Commenting in any detail on the future of programming is a task that's open to interpretation. Although I don't make a habit of predicting the future, when I do I start by examining past trends. One that's been evident since the beginning of programming is that layers are continually being added to the bedrock (or quicksand!) underneath. I don't see anything happening soon that bucks this trend.

Consider a Web page designer who's using ActiveX controls written in Microsoft Visual Basic. Those ActiveX controls may use a database as well as controls written in C++. The programmer writing the C++ controls uses a compiler written by a team of tools programmers. The C++-control author also makes calls to the operating system. The authors of the operating system rely on device drivers that communicate with the machine's hardware, which are written by yet another type of programmer.

My point is that what we call "programming" can be interpreted in a variety of ways. The future of programming will depend on the type of programming you're doing. It's a safe bet that the changes in store for an HTML programmer will be far different than those for a compiler writer. Similarly, the magnitude of the changes should be roughly equal to how high in the software layer your particular kind of coding resides. Newer layers will undergo

"Adding complexity to a programmer's life is the



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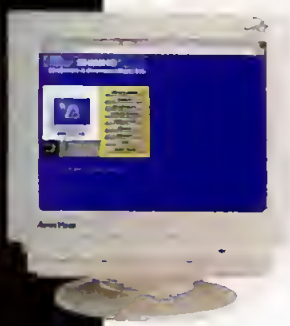


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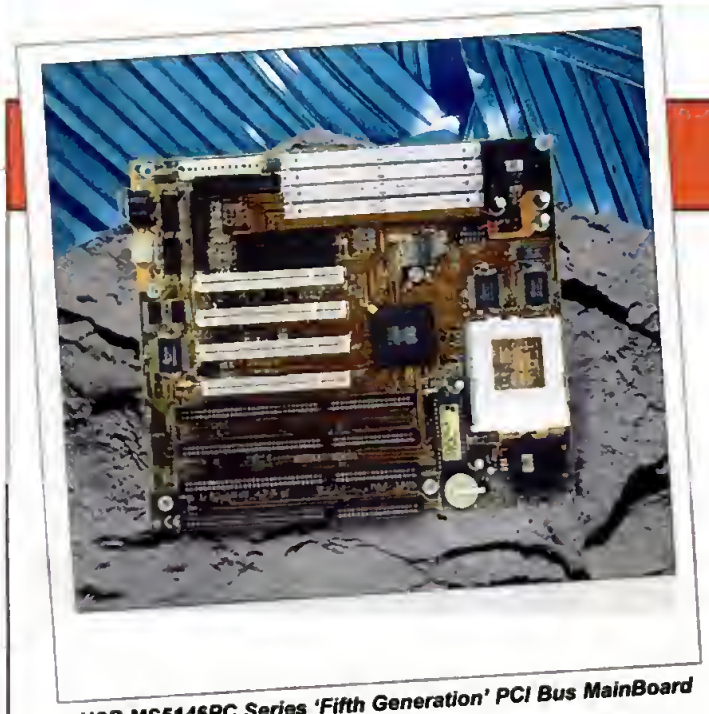
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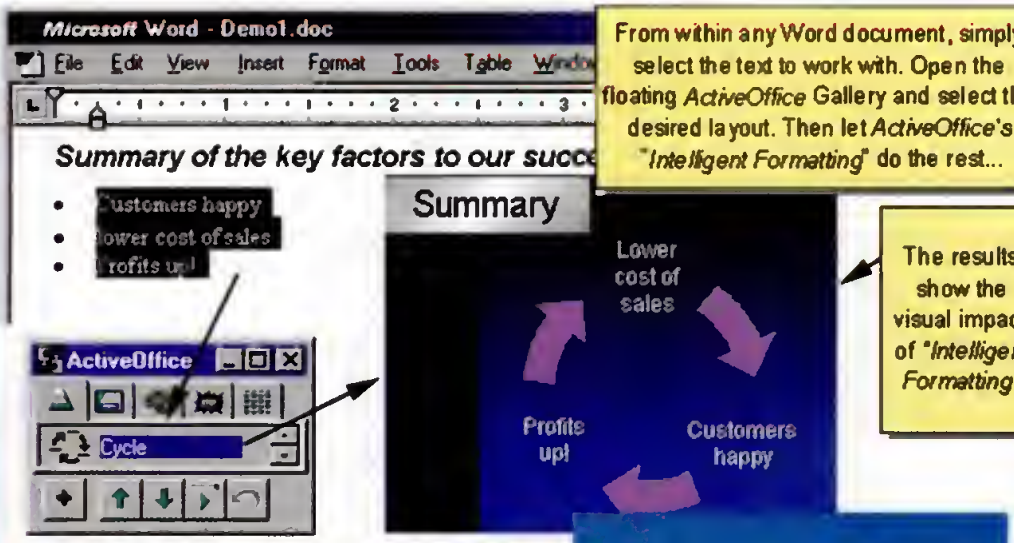
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more change and improvement than older, more established layers.

Adding complexity to a programmer's life is the emergence of cross-platform programming in conjunction with interpreted languages, such as HTML, Java, and Visual Basic. In the past, interpreted languages were often shunned because they weren't fast enough. Now, however, processing power is cheap and fast. Most interpreted programs will probably run "fast enough" on any desired target platform. I attribute much of the rise of the Web to hardware and languages that perform reasonably well in an interpreted environment.

While writing a program once and having it run on many platforms sounds appealing, problems have and will continue to arise. For starters, an interpreted language often makes it difficult to take full advantage of a particular hardware platform's capabilities. Likewise, just because a particular language claims to work the same across platforms doesn't mean it will. Little kinks and differences always creep in. When you combine all the layers in today's software with the demand that code run across many platforms, the result is an increasingly difficult life for the typical programmer. Sure, you might be able to construct a database query in one line of code, but how do you track down the problem when the query fails? In this environment, tools and techniques for monitoring and finding problems in the interactions between layers become more essential. And this means that programmers who can design, code, and debug across multiple layers in a system will be in high demand. Programmers who stick only to a particular niche may soon find themselves obsolete.

***Matt Pietrek** writes the Under the Hood column in the* Microsoft Systems Journal *and has written several books about operating system internals. He is also a senior architect of the BoundsChecker series of products for NuMega Technologies, of Nashua, New Hampshire. In addition, Matt gives Win32 seminars for David Solomon Expert Seminars.*

Jeff Prosise

If there's one thing that's clear about the future of Windows programming, it's that the Component Object Model (COM) will play a huge role in it. COM is Microsoft's answer to the problem of binary-object portability, and it's the basis for ActiveX controls, applications that display documents within Internet Explorer 3.0, and other OLE wizardry.

COM is also becoming an integral part of the operating system itself. Some of the key features of Windows 95 and Windows NT 4.0, for example, are exposed not through API functions but through COM interfaces.

The bad news, of course, is that writing COM code is more tedious and error-prone than writing to the Windows API. Writing an OLE document server in C++ with a good class library to help out is no picnic, but it is possible; writing the same application in C is a little like building your own 767. As COM proliferates, even the more traditional programmers among us will be compelled to use class libraries, such as the Microsoft Foundation Classes (MFC) or the ActiveX Template Library (ATL). Soon, the programmer who writes to the Windows API will be looked upon the way assembly language programmers are today. Those who fail to accept the new world order risk obsolescence.

"As COM proliferates, even the more traditional programmers among us will be compelled to use class libraries, such as MFC or ATL."



***Jeff Prosise** specializes in Windows programming. His latest book,* Programming Windows 95 with MFC, *is published by Microsoft Press. A longtime programmer who cut his teeth on Windows writing 16-bit apps using C and the SDK, Jeff today codes almost exclusively for the Win32 platform using C++ and MFC. In addition to writing columns for* PC Magazine *and the* Microsoft Systems Journal, *Jeff frequently speaks at industry programming conferences.*

Neil J. Rubenking

Programming is getting easier all the time. Myriad products are available that let you create programs without programming, manage databases without knowing a field from a record, and distribute applications over the Internet without writing a line of code. Or so we're told. In truth, the imaginary utopia in which every user is an instant programmer hasn't arrived, although it may be closer than we think.

Programming tools have improved immensely every year, but the programmer's job hasn't gotten any easier. Yes, integrated development environments and object-oriented programming make it easier to re-use code, set up user interfaces, and create standard applications from predefined components. But the underlying operating systems have exploded in complexity, to the point that it's nearly impossible for a programmer to know all of the services available in an OS, much less all of the API functions. User expectations have risen as well, so programmers need to work just as hard as ever.

But we are seeing a certain stratification of programmers—a sort of modern caste system. At present, the two major groups are those who create components and those who use components, with a third, much smaller group of Brahmins who write the underlying operating systems. This is as it should be—building a component that turns any program into an instant Web site is one type of work, while integrating that component into a particular application is something completely different. The problem is, there's another artificial distinction that obscures this logical caste system: Programmers are divided according to the platform they work under and the programming language they use. I write in Delphi for 32-bit Windows; he writes in COBOL for Unix; she writes in C++ for OS/2. To date, every dream of widely used and truly interchangeable software components has been derailed by this division.

There's hope, though, in cross-platform programming languages like Java and cross-platform object standards like ActiveX. Whether through one common standard or multiple compatible standards, programmers will eventually be able to use components without regard for platform or programming language. And after a few years of refinement, programming by assembling components may well be within the reach of every computer user. Today's programmers needn't worry about job security, though. We'll be very, very busy writing those components.

"In truth, the imaginary utopia in which every user is an instant programmer hasn't arrived, although it may be closer than we think."



***Neil J. Rubenking** is the contributing technical editor of* PC Magazine. *His User-to-User column initiates readers into the mysteries of DOS and Windows, and his frequent contributions to the Utilities column both provide useful programs and teach programming concepts. Neil has written seven books on DOS, Windows, and programming, including* Delphi Programming for Dummies *and* Delphi Programming Problem Solver, *both from IDG Books.*

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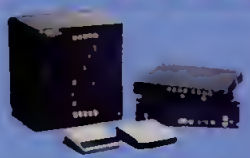
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PC MAGAZINE EDITORS' CHOICE

April 7, 1996
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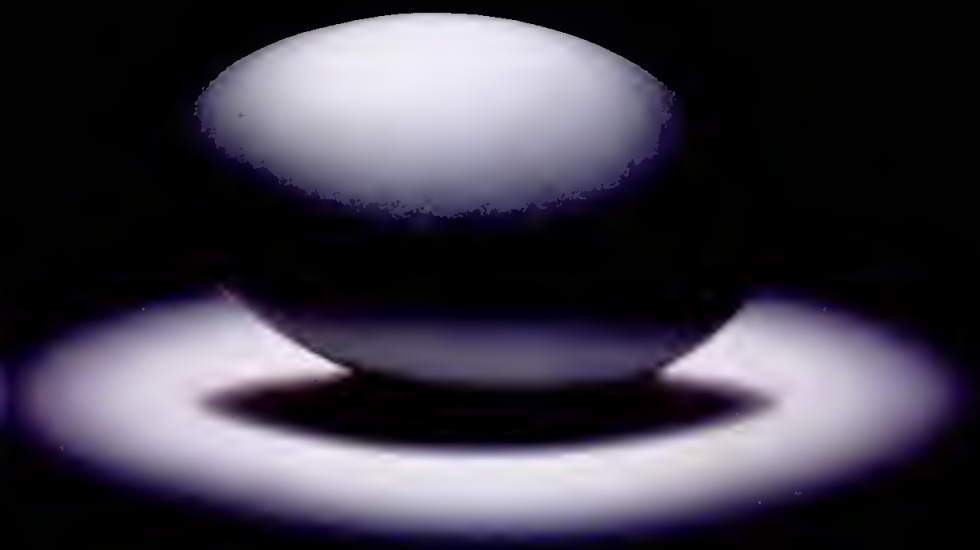
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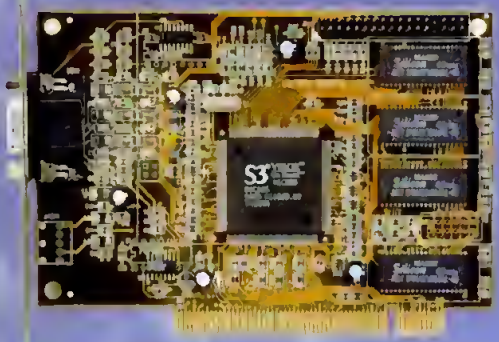
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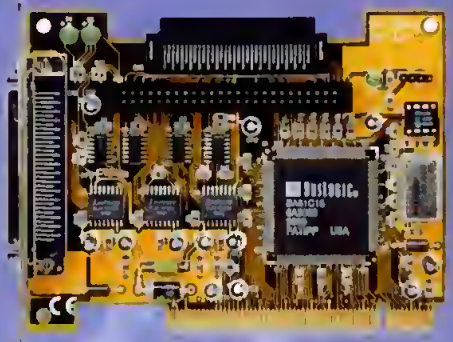
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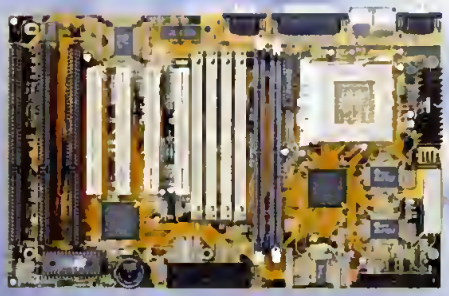
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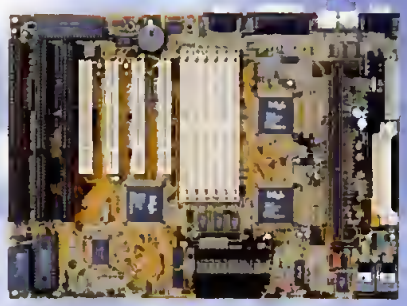


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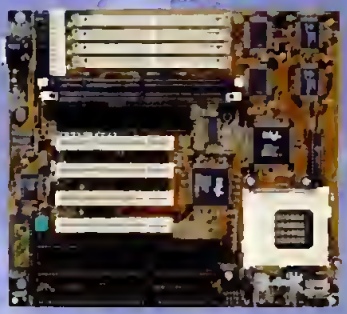
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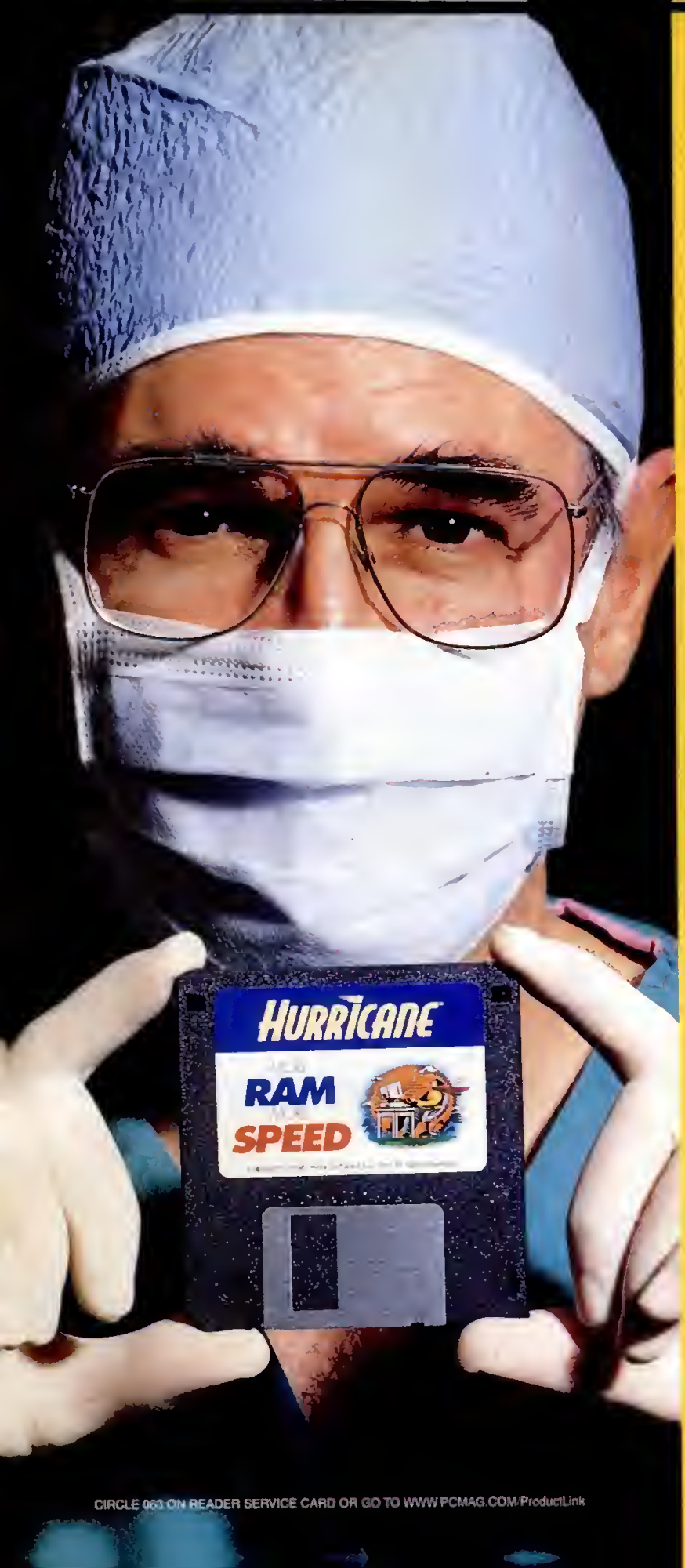
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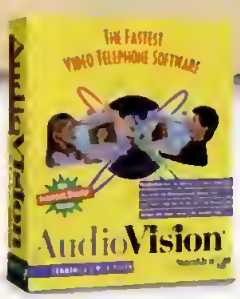
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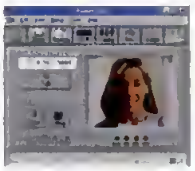
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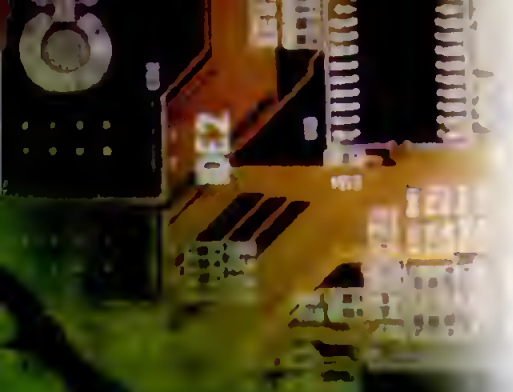
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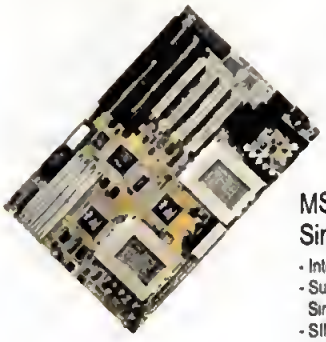
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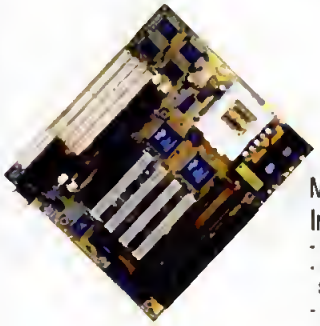

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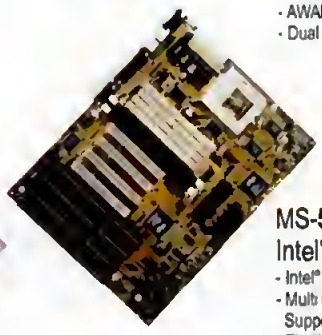
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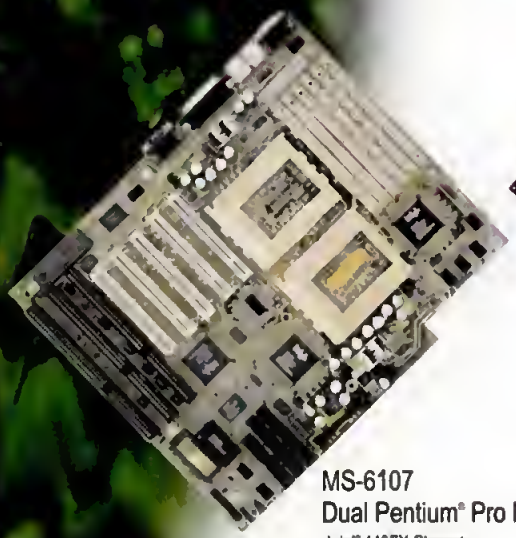
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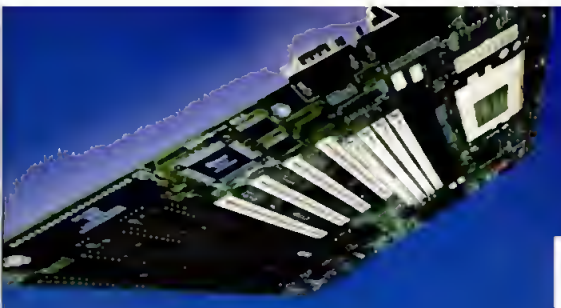
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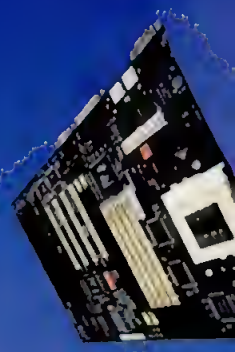
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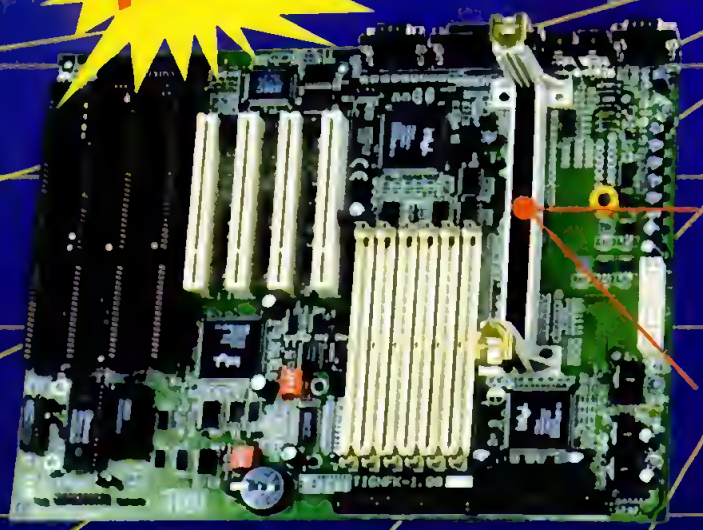
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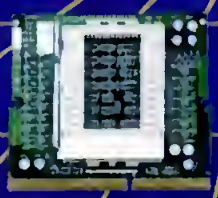


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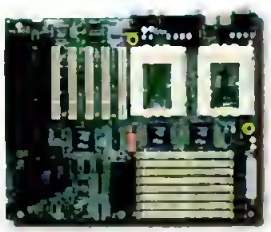
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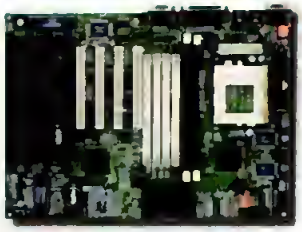
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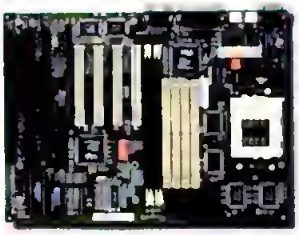
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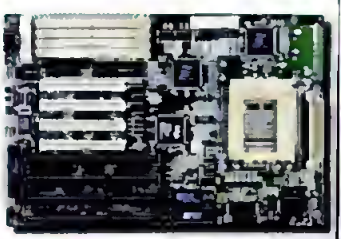
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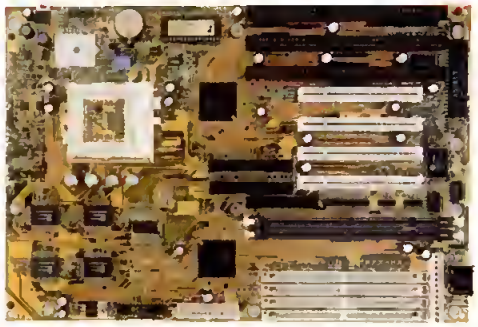
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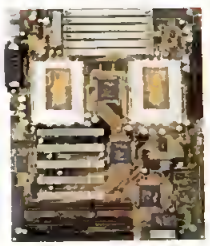
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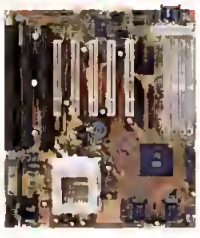
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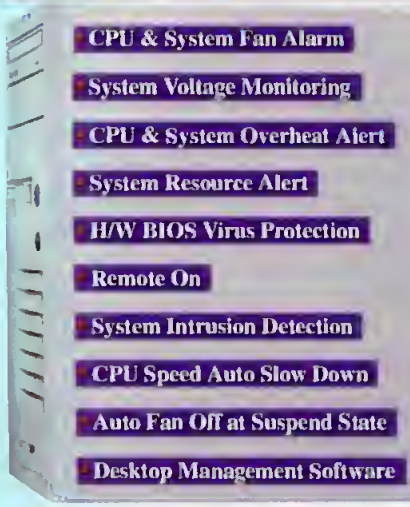
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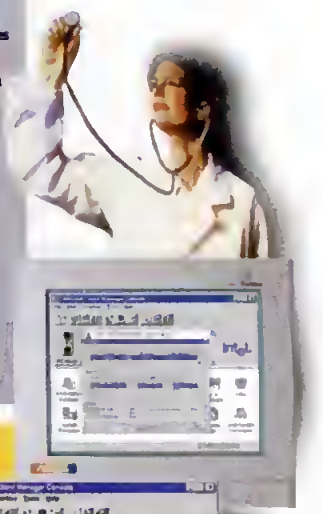
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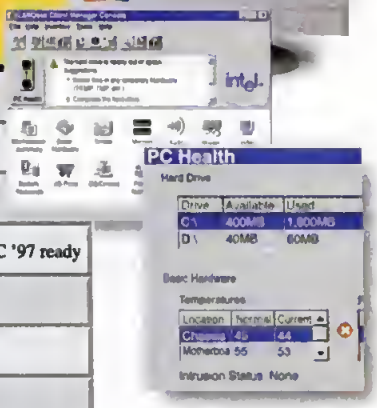
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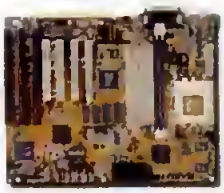
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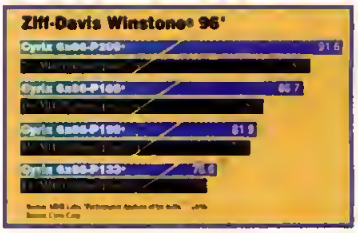
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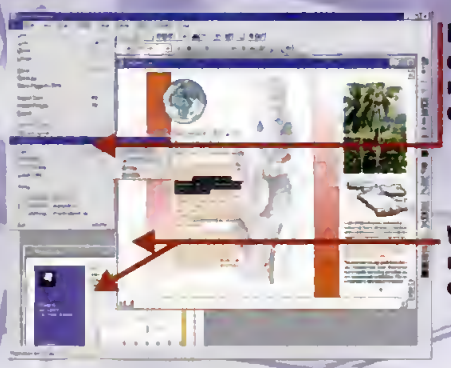
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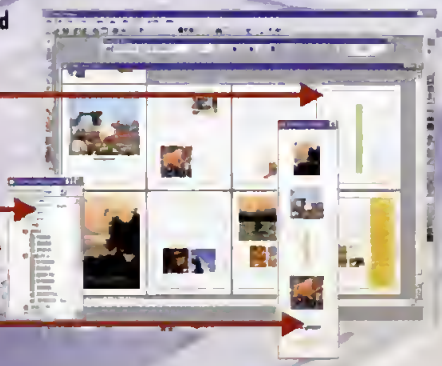
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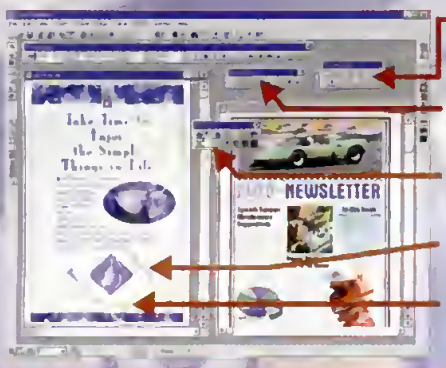
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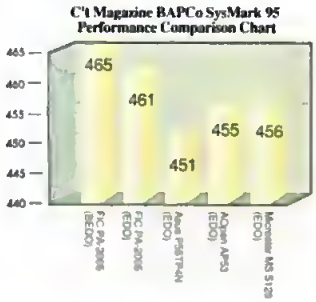
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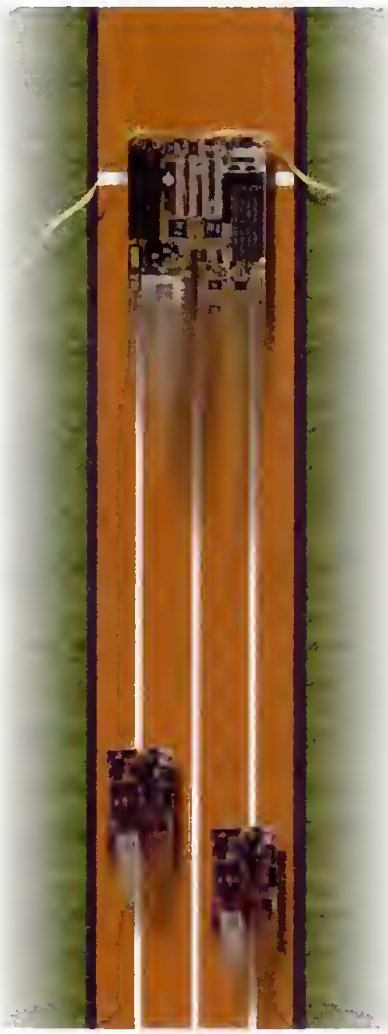
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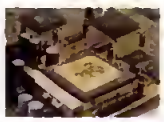
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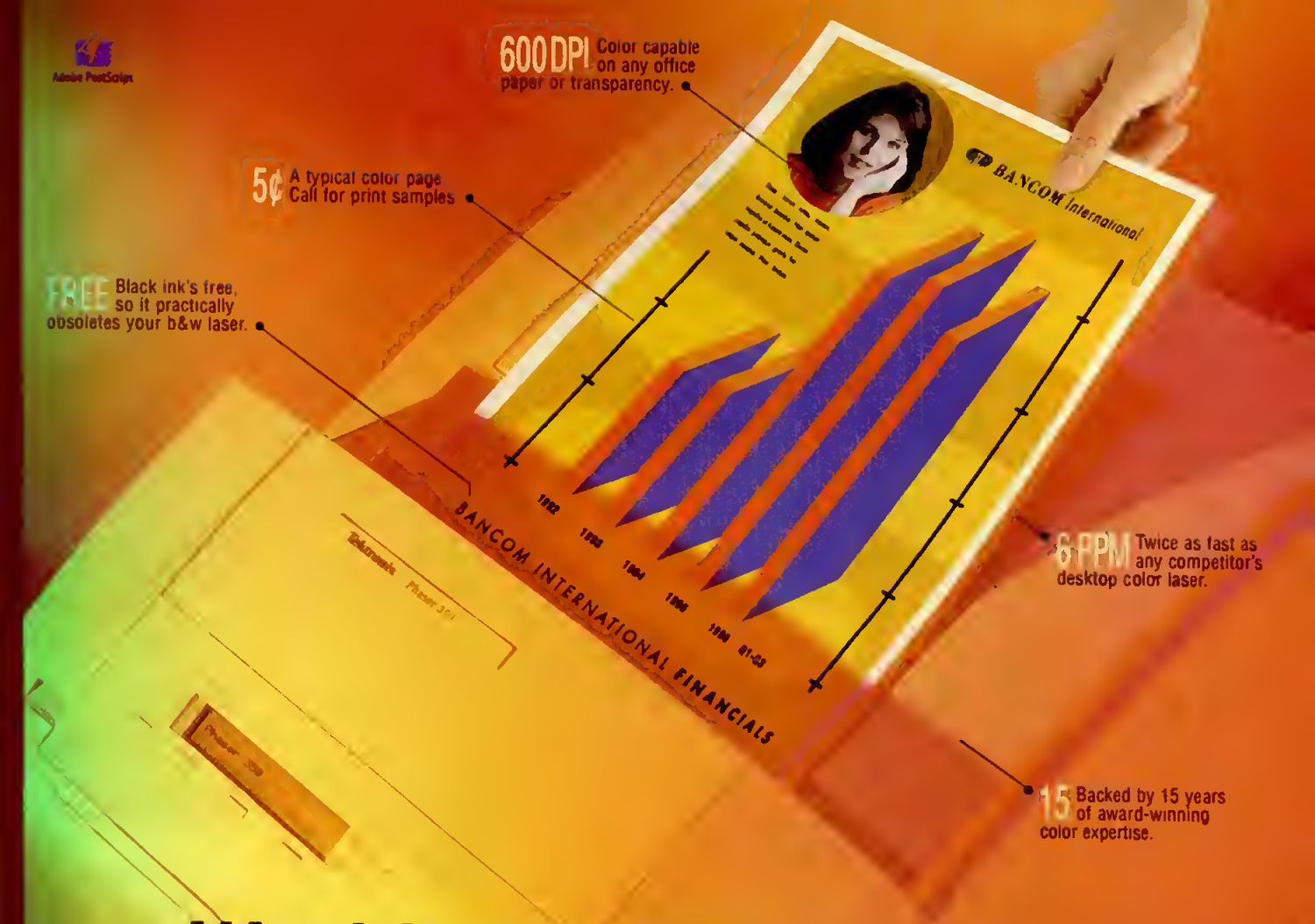
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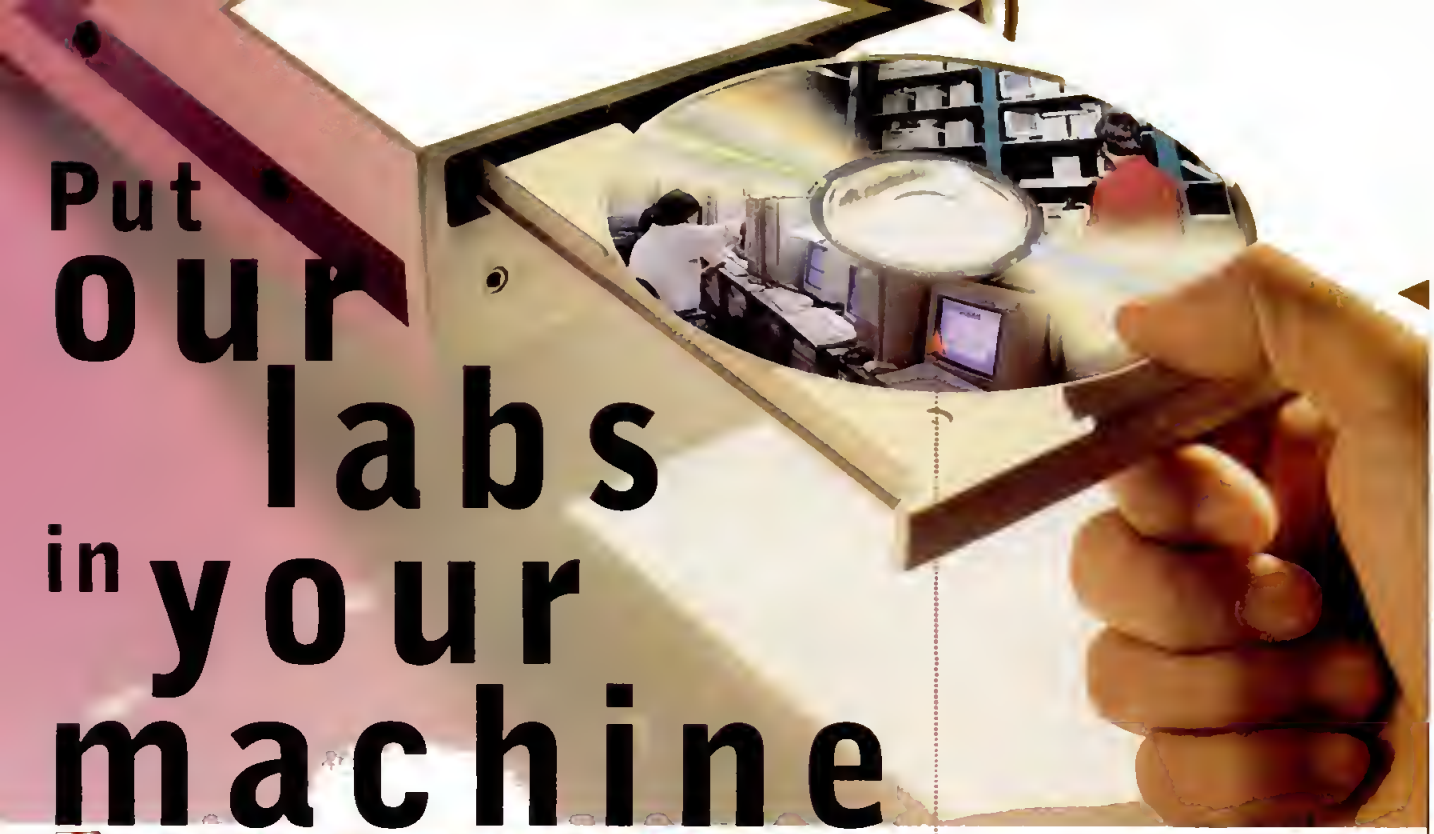
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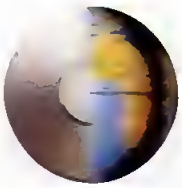
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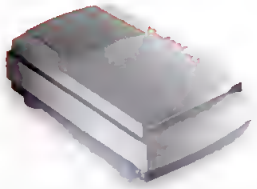
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PLUS: Pre-installed software including user-selectable Windows® 95 or Windows® for Workgroups and MS-DOS®

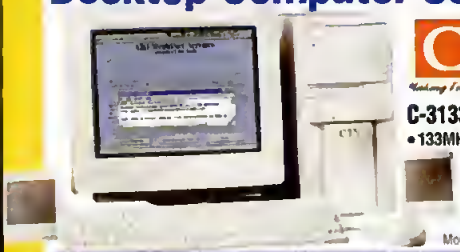
- 120MHz Pentium® processor for speedy performance
- 16MB EDO DRAM expands to 48MB for smoother operation of your business applications
- 11.3" diagonal color screen with 800x600 resolution provides easy, on-screen viewing
- Easy swapability of 10X CD-ROM drive and floppy disk drive works the way you choose
- Full-motion MPEG video with Zoomed Video (ZV) Technology
- Two built-in PC Card slots are ready for Internet and network connections

intel inside pentium

Model	Processor Speed	RAM Std/Max	HDD	Display	Order #	Price	Lease
430CDS	Pentium 120MHz	16/48 MB EDO	1.2 GB	11.3" SVGA DS	#38816	$2449	$99
430CDT	Pentium 120MHz	16/48 MB EDO	1.2 GB	11.3" SVGA TFT	#38817	$3299	$132

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- 133MHz Intel® Pentium® processor
- 1.2GB hard drive
- 16MB EDO RAM
- 8x CD-ROM
- 33.6 faxmodem

Monitor sold separately

intel inside pentium

Mfr.	Model	Processor	Chassis	HD	RAM	CD	Order #	Zone Price
AST Computer	Bravo MS-T	P100	MiniTower	1.2GB	16MB	-	33590	$1,149.00
AST Computer	Bravo MS	P166	Desktop	2.0GB	16MB	8x	38787	$1,899.00
AST Computer	Bravo MS-T	P166	MiniTower	2.0GB	16MB	8x	38814	$1,939.00
AST Computer	Bravo MS-T	P200	MiniTower	2.0GB	16MB	8x	38837	$2,159.00
Compaq	Presario 9240	P133	Desktop	1.2GB	16MB	4x	36032	$1,299.00
Compaq	Presario 4764	MMX166	MiniTower	2.5GB	24MB	16x	42900	$1,899.00
Compaq	Presario 4770	MMX200	MiniTower	3.8GB	32MB	16x	42901	$2,299.00
Compaq	Presario 4784	MMX200	MiniTower	4.3GB	32MB	16x	42902	$2,399.00
Compaq	Presario 8772	MMX200	MiniTower	6.5GB	48MB	16x	42903	$2,999.00
CTX Best Buy!	C3133	P133	MiniTower	1.2GB	16MB	8x	39691	$999.98
CTX	C3166	P166	MiniTower	2.0GB	16MB	8x	39692	$1,349.00
CTX	C3200	P200	MiniTower	2.0GB	16MB	8x	39693	$1,599.00
Hewlett-Packard	Vectra 520MCx	P120	Desktop	1.2GB	12MB	8x	39665	$1,399.00
Hewlett-Packard	Vectra 520	P133	Desktop	1.2GB	12MB	-	39664	$1,149.00
Hewlett-Packard	Vectra 525CD	P166	MiniTower	1.6GB	16MB	8x	39668	$1,699.00
Hewlett-Packard	Vectra 525CD	P200	MiniTower	2.5GB	16MB	8x	39670	$2,049.00
IBM	Aptiva C33	P133	MiniTower	1.6GB	16MB	8x	36653	$1,469.00
IBM	PC 350	P133	Desktop	1.2GB	16MB	-	42383	$1,499.00
IBM	Aptiva C55	P150	MiniTower	2.0GB	16MB	8x	36654	$1,498.00
IBM	Aptiva C65	P166	MiniTower	2.0GB	16MB	8x	36658	$1,699.00
IBM	Aptiva S64	P166	MiniTower	2.5GB	16MB	8x	36723	$1,899.00
IBM	Aptiva S66	P166	MiniTower*	3.2GB	16MB	8x	36724	$1,999.00
IBM	PC 350	MMX166	Desktop	Open	16MB	-	42387	$1,799.00
IBM	PC 330	MMX166	Desktop	2.5GB	16MB	-	42382	$1,999.00
IBM	Aptiva C77	P200	MiniTower	3.2GB	16MB	8x	36657	$2,299.00
IBM	PC 350	MMX200	Desktop	2.5GB	32MB	-	42388	$2,499.00
Packard Bell Refurb	BL202	486 DX2/66	Desktop	540MB	8MB	2x	39271	$499.98
Packard Bell Refurb	BL223	P100	MiniTower	2.1GB	16MB	4x	37726	$799.98
Sony	VAIO PCV-70	P166	MiniTower	2.1GB	32MB	8x	83701	$1,599.00
Sony	VAIO PCV-100	MMX166	MiniTower	2.5GB	32MB	16x	42904	$1,999.00
Sony	VAIO PCV-90	P200	MiniTower	2.5GB	32MB	8x	83702	$1,799.00
Sony	VAIO PCV-120	MMX200	MiniTower	3.8GB	32MB	16x	42905	$2,399.00

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Ascentia A41

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US Robotics

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32788 Pilot 5000 $289.99

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Fujitsu

30810 ISDN PC CARD $299.98

IBM

32421 PC Card Type II 28.8/14.4 Data/Fax Modems $233.84

Simple Technology

39171 33.8 Communicator w/Simple Jack $175.71

TDK

21500 28.8 V.34 Cellular Data/Fax PCMCIA $184.96

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30334 XJEM3288C - 28.8 XJack Fax/Modem/LAN 10-T/10-2 $349.95

31064 XJEM3288T - 28.8 XJack Fax/Modem/LAN 10-T $399.98

Mobile-Network Cards

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Fujitsu

30801 10BaseT LAN PC CARD $87.64

IBM

38810 10T EtherJet PCMCIA Adapter $114.86

38812 10T/10B2 EtherJet PCMCIA Combo Adapter $143.48

25649 Token Ring PC Card Adapter $314.91

Megahertz

24846 XJ 10BC PCMCIA X Jack 10T/BNC $134.02

Socket Communications

21523 EA+ 10baseT PCMCIA Ethernet Adapter $113.58

19935 EA+ PCMCIA Ethernet Adapter $141.40

Xircom

21066 PCMCIA TR 16 Bit $346.52

Mobile-SCSI/Serial Adapters

Fujitsu

30803 LAN/SCSI Combo PC CARD $235.28

30804 SCSI 600 Card $72.36

30804 SCSI 600 PC CARD $72.36

30809 Serial PC CARD $67.10

30809 Serial PC Card Adapter $67.18

New Media

39622 Basics SCSI (DB-25) PCMCIA Adapter $92.91

Socket Communications

19936 I/O PCMCIA Serial Adapter $135.63

34594 Infrared Serial Adapter $159.99

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MicroSolution backpack Parallel Port 4X CD-ROM Drive

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27505 Addonics Portable CD-ROM Drive 4X $191.82

Fujitsu

36258 EgorMedia 6x CD-ROM w/PCMCIA Adapter $318.18

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35366 Backpack PD/CD-ROM Drive $501.25

31079 Backpack Plug and Play 4X CD-ROM Drive $214.55

31890 Backpack Plug and Play 4X CD-ROM Dr w/Sd $309.32

35363 Backpack Plug and Play 8X CD-ROM Drive $333.30

35352 Backpack Plug and Play 8X CD-ROM Dr w/Sd $427.95

Mobile-Multimedia Cards

AlTech

30634 Pocket Scan Converter $97.17

30632 Road Warrior Presenter $344.76

Fujitsu

30808 Stereo Sound PC CARD $100.84

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39623 Basics GAMEpak Joystick Bundle $90.90

39624 Basics GAMEport $58.07

30318 Gamejammer PCMCIA $170.45

35105 Laptalk Stereo Speakers $80.91

26023 WAVjammer 16-bit PCMCIA Sound Stereo $280.76

Mobile-Cases

Targus

91934 Targus Leather Case with CPU Purchase Promo $74.43

06610 Targus Leather NoteBook Case - Black $88.23

06023 Targus Notepac Case Black $28.99

07454 Targus Universal PowerBook Case $59.32

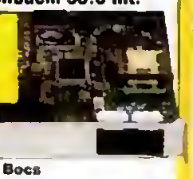
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35130 Cardinal 33.6 v.34 Fax/Modem External PnP $136.42

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Nayes

38865 Total Internet Solution Accura 336 Ext $158.62

38864 Total Internet Solution Accura 336 Int $141.75

Motorola

37483 Premier 33.6 V.34 Fax/Modem $255.00

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36291 33.8 Int Data/Fax $89.55

36289 33.6 Int Fax/Modem w/Voice $85.91

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32630 SupraExpress 336i PnP Internal $95.97

82591 SupraExpress 336i SP Speakerphone Int $122.38

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19449 Sportster V.34 28.8/33.6 Ext Fax/Modem t/Win $158.59

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33334 Sportster Voice 28.8/33.6 External w/Speaker $190.57

33333 Sportster Voice 28.8/33.6 Internal w/Speaker $162.84

32995 Sportster WinModem 14.4 Internal $29.98

32088 Sportster WinModem 28.8 Internal $111.06

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34185 Ultima Viewscan A2000D $117.22

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28202 Hewlett-Packard ScanJet 4C PC $855.51

85463 Hewlett-Packard ScanJet 4P $486.23

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32596 PageScan Color Pro w/ADF $309.83

32597 ScanMan Color 2000 Parallel $117.30

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36165 ScanMaker E3 PC Standard $303.76

35167 ScanMaker III PC w/Trans. Media Adapter $1,385.00

Minolta

38405 Snappy 2.0 $188.98

UMAX

83502 Vista S6e w/Photodeluxe $288.89

83506 Vista-S12 PC w/Photoshop LE $613.56

30131 Vista-S12 w/Photodeluxe $519.67

Visioneer

43651 Visioneer PaperPort ix for Windows. $289.98

87562 Visioneer PaperPort Vx For Windows $275.27

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35114 3D XPRESSION (PCI) $144.43

36732 3D XpressionPlus PC2TV 2MB (PCI) $149.34

36733 3D XpressionPlus PC2TV 4MB (PCI) $171.64

19910 Graphics XPRESSION 2MB (ISA) $93.76

Nercules

31846 Dynamite128 PCI 2MB MDRAM $113.62

36721 Terminator 3D 4MB PCI EDO DRAM $135.84

35677 Terminator 64/Video PCI 2MB EDO MPEG $150.58

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24036 9FXMotion 771 2MB VRAM PCI $230.98

24837 9FXMotion 771 4MB VRAM PCI $345.76

TrueVision

27633 Bravado 1000 for Windows $644.44

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25444 Adesso PC Propoint Ext Keyboard w/Pointer $47.06

25477 Adesso Tru-Form Ergonomic Kyb w/o Pointer $47.06

32623 Adesso Tru-Form w/TouchPad $75.76

Cirque

30225 Cirque Glidepoint Desktop for PC $58.71

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Lexmark Color JetPrinter 1020	600x300	3/2	—	29K	8.5x14"	#31815	$159.98
Canon BJC-240	360x360	3/.27	7/300	62K	8.5x14"	#34189	$178.98
Canon BJC-4200	720x360	5/1	7/300	64K	8.5x14"	#34189	$278.98
Canon BJC-620	720x720	4/1.7	7/300	60K	8.5x14"	#34190	$398.98
Canon BJC-4550 Wide	720x360	5/1	7/300	64K	11x17"	#34191	$499.98
Canon BJC-70 Portable	720x360	4/.8	7/20	35K	8.5x14"	#21969	$292.98
EPSON Stylus Color 500	720x720	4/1	5/4	56K	8.5x14"	#83409	$279.98
EPSON Stylus Color Pro	720x720	3/1	5/4	56K	8.5x14"	#89901	$379.98
EPSON Stylus Color 1500	720x720	3/1	5/4	256K	13.6x21.78"	#86318	$995.98
EPSON Stylus Color Pro XL	720x720	3/1	5/4	64K	12.76x18.33"	#87980	$1799.00
HP DeskJet 340 Portable	300x300	3/2-4	6/0	16K	8.5x14"	#27969	$279.98
HP DeskJet 400	600x300	3/1.5		16K	8.5x14"	#36155	$169.98
HP DeskJet 682C	600x300	5/1.5	0/32	512K	8.5x14"	#86325	$269.98
HP DeskJet 693C	600x600	4/1.7	8/35	512K	8.5x14"	#82656	$299.98
HP DeskJet 820Cse	600x600	6.5/4	0/50	128K	8.5x14"	#86326	$399.98
HP DeskJet 870Cse	600x600	8/4	26/126	1MB	8.5x14"	#36156	$499.98
HP DeskJet 1600C	600x600	9/4	1/35	4/100MB	8.5x14"	#31868	$1349.00

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Brother HL-720 Windows	600x600	6	0/35	512K/2MB	8.5x14"	#31838	$349.98
Brother HL-730 DOS/Windows	600x600	6	0/35	512K/2MB	8.5x14"	#34168	$399.98
HP LaserJet 5L Xtra	600x600	4	0/26	1/9MB	8.5x14"	#36154	$479.98
HP LaserJet 5P Reconditioned	600x600	6	35/75	2/50MB	8.5x14"	#86348	$549.98
HP LaserJet 5P	600x600	6	35/75	2/50MB	8.5x14"	#23556	$769.98
Okidata OP4W	600x600	4		128K	8.5x14"	#34167	$299.98
Okidata OL410e/PS	300x1200	4	12/0	2/5MB	8.5x14"	#93689	$449.98
Okidata OL810e	300x600	6	35/10	2.5/18.5MB	8.5x14"	#26951	$489.98
Okidata 810e	600x1200	8	35/10	2/34MB	8.5x14"	#23493	$699.98
Okidata 1200	600x600	12	35/10	6/34MB	8.5x14"	#24596	$929.98
Lexmark Optra E	600x600	6	0/26	1/5MB	8.5x14"	#31617	$499.98
Lexmark Optra R+	1200x1200	16	39/45	4/64MB	8.5x14"	#36049	$1479.00
Lexmark Optra N	600x600	24	39/45	4/64MB	8.5x14"	#35278	$2679.98
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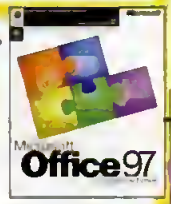


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30638 LifeTime Wireless Keyboard w/TouchPad	$132.08
30637 LifeTime Wireless Keyboard w/Trackball	$115.08
32639 Logitech Cordless MouseMan Pro	$70.56
31166 Logitech MouseMan '96	$53.62
25431 Logitech TrackMan Marble	$85.02

Microsoft

39010 MS IntelliMouse f/Win 95	$64.49
31782 MS Mouse IntelliPoint – PS/2 Connector	$54.49
31781 MS Mouse IntelliPoint – Serial Connector	$54.49
25008 MS Natural Keyboard for Windows 95	$99.99
37830 MS SideWinder 3D Pro Joystick w/Hellbender	$18.89
37850 MS Sidewinder Gamepad for Win 95	$35.58

ThrustMaster

32555 ACM Game Card	$30.11
39948 ThrustMaster F22 Pro Flight Control	$134.62
32600 ThrustMaster FormulaT2	$117.64

Wacom

23390 ArtZ II 12x12 (srl) w/Erasing UltraPen	$435.22
23388 Wacom ArtPad II (serial) w/Dabbler Bundle	$151.56
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05689 ACS-300 Speakers w/Sub Woofer	$198.73
82559 ACS-45 Speaker System - 20w	$87.40
31171 ACS-500 Speakers w/Dolby Surround Sound	$348.25
82560 ACS-55 Gamma Audio System – 30w	$173.36

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31821 AcoustiMass Multimedia Powered Speakers	$599.99
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93857 YST M7 Speaker (Platinum) – 10w	$41.48
85800 YST-M15 Powered Speakers (Black)	$80.00
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26169 Ditto Easy 800MB External Par Port Tape Drive	$149.98
25659 Jaz 1GB External Drive	$499.99
22339 Zip 100 Parallel Port	$199.99
91825 Zip 100 SCSI	$199.98

SyQuest

33347 SyQuest EZFlyer 230 Parallel	$298.89

CD-ROM Drives

Addonics

27505 Portable CD-ROM Drive 4X	$151.82

Axonix

24824 Axonix ProMedia Player	$204.43

Creative Labs

36281 Sound Blaster 16 Value IDE Sound Card	$92.18
36280 Sound Blaster 32 PnP Sound Card	$137.56
36281 Sound Blaster AWE32 PnP Sound Card	$92.16
30827 Sound Blaster Discovery CD 8x Internal PnP	$257.58

Hi-Val

37265 Hi-Val 10X IDE CD Kit	$126.25
24804 Hi-Val 4 4X Internal SCSI CD-ROM Drive	$113.62

NewCom

36701 NewCom 12X CD-ROM Drive Internal IDE	$204.43
36702 NewCom 12X Internal Multimedia Kit	$295.34
35110 NewCom 8X CD-ROM Drive Internal IDE	$162.18
36709 NewCom 8X Internal Multimedia Game Kit	$181.70

Philips

85839 Philips 8X External CD Drive	$323.18
33604 Philips CDD2000/12 Internal CD Recorder	$588.36
33605 Philips CDD2010/12 External CD Recorder	$584.42

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27544 CPU MAXimizer 486DX4-100	$97.83
30811 CPU MAXimizer 586-133	$119.57

Intel

32015 Intel Pentium Overdrive 120/133MHz f/P60/66	$252.48
32017 Intel Pentium Overdrive 150MHz for P90	$320.01
32018 Intel Pentium Overdrive 166MHz for P100	$457.72
28155 Intel Pentium Overdrive 63MHz	$135.29
28615 Intel Pentium Overdrive 83MHz	$168.03

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94359 APC Back-UPS 200	$89.27
05901 APC Back-UPS 450	$173.77
11651 APC Back-UPS 600	$237.18
88537 APC Back-UPS Pro 1000	$376.18
81900 APC Back-UPS Pro 420 PnP	$233.33
94395 APC Personal Surge Arrest 7 Outlet w/Phone	$19.85
94394 APC Prof Surge Arrest 7 Outlet	$24.98
94393 APC Prof Surge Arrest 7 Outlet w/Phone	$32.23
25581 APC SmartSlot Expand	$89.40

Optiquest

34522 OPTI-UPS 1400 Uninterruptible Power System	$412.07
34526 OPTI-UPS 280 PnP Uninterruptible Pwr Sys	$95.76
34527 OPTI-UPS 420 PnP Uninterruptible Pwr Sys	$144.00
25890 OPTI-UPS 650E Uninterruptible Power System	$220.89

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BestWare

09800 MYOB Accounting 7.0	$76.00
15056 MYOB Accounting with Payroll 7.0	$114.98

Claris

32979 Claris FileMaker Pro 3 Win 3.1 Win 95/NT	$151.62
18192 Clarisworks 4.0 for Windows 95	$44.00
90901 Clarisworks Home Solution Pack	$17.62

Corel

32988 Corel Office Professional 7 Windows 95	$252.18
32905 Corel Quattro Pro 6.1 for Windows 3.1x	$82.37
32980 Corel Quattro Pro 7 Windows 95 CD	$62.37

Intuit

13286 Quickbooks 4.0 for Windows	$93.66
23930 Quickbooks Pro 4.0 for Windows	$182.34
09768 Quicken 6.0	$33.51
13973 Quicken Deluxe 6.0	$57.52
25809 Quicken Expensable	$43.94

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By Jeff Prosise

Building Applications with Visual C++, Part 4

This time we draw our game's graphical elements on-screen.

You've joined a lesson in progress. For the past three issues, we've been learning about programming in Visual C++ by writing a simple tic-tac-toe application for Windows. The game is played on a 5-by 5-square grid, and the object is to line up four consecutive X's or O's horizontally, vertically, or diagonally.

AppWizard started us off by generating the code we used as the skeleton for our application. Next, we added to the view an OnLButtonDown handler, which displays a message box when a square is clicked with the left mouse button. We've also developed a document class that includes the infrastructure necessary to store the X's and O's a user enters and to keep track of whose turn it is. The goal in this column is to wire the document and the view together so that clicking an empty square places an X or O at the proper location in the grid. Our application will then be complete except for a few details, which we'll polish off next time.

ONLBUTTONODWN REVISITED

To be able to have our application draw X's and O's in response to mouse clicks, we need to modify the view's OnLButtonDown function. The function already includes hit-testing logic that allows the application to ignore clicks outside of the playing grid. The next step is to replace the code that displays a message box when a square is clicked with code that places an X or O in an empty square.

The finished OnLButtonDown handler is shown in Figure 1. When a square is clicked, the updated version of OnLButtonDown calls the document's GetSquare function to determine if there is an X or O in the square. If GetSquare returns 0, the square is empty, and OnLButtonDown calls the document's IsItXsTurn function to determine whether an X or O should be inserted. It then calls the document's AddX or AddO function to record an X or O at the appropriate location in the grid, followed by the view's DrawX or DrawO.

DRAWING X'S AND O'S

If you try to rebuild the application after making the modifications shown in Figure 1, you'll get error messages from the compiler, because OnLButtonDown calls a pair of view functions—DrawX and DrawO—that haven't been written yet. The next logical step, then, is to implement those functions.

Figure 2 shows the finished DrawX and DrawO functions. Both are members of the view class CTicView, and both use CDC output functions to draw. DrawX creates a red pen 10 units wide (or one-tenth of a logical inch, in the MM_LOENGLISH mapping mode) with the statement

```
CPen pen (PS_SOLIO, 10, RGB (255, 0,0));
```

It then draws a pair of crisscrossing lines with the statements

```
pDC->MoveTo (rect.left, rect.top);
pDC->LineTo (rect.right,
             rect.bottom);
pDC->MoveTo (rect.left,
             rect.bottom);
pDC->LineTo (rect.right, rect.top);
```

Similarly, DrawO creates a blue pen 10 units wide with the statement

```
CPen pen (PS_SDLID, 10, RGB (0, 0,
255));
```

```
void CTicView::DnLButtonDown(UINT nFlags, CPoint point)
{
    //
    // Get a pointer to the document.
    //
    CTicOoc* pOoc = GetOocument ();

    //
    // Get a OC and convert point to logical coordinates.
    //
    CClientDC dc (this);
    dc.SetMapMode (MM_LOENGLISH);
    dc.DPtoLP (&point);

    //
    // Hit test the grid and draw an X or O if
    // appropriate.
    //
    BOOL bOuit = FALSE;
    for (int i=0; i<5 && !bOuit; i++) {
        for (int j=0; j<5  && !bOuit; j++) {
            if (m_rect[i][j].PtInRect (point)) {
                if (pDoc->GetSquare (i, j) == 0) {
                    if (pOoc->IsItXsTurn ()) {
                        pOoc->AddX (i, j);
                        DrawX (&dc, &m_rect[i][j]);
                    }
                    else {
                        pOoc->AddO (i, j);
                        DrawO (&dc, &m_rect[i][j]);
                    }
                }
                bOuit = TRUE;
            }
        }
    }

    //
    // Let the base class do its thing.
    //
    CView::OnLButtonDown(nFlags, point);
}
```

FIGURE 1: *The finished OnLButtonDown function.*

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```
void CTicView::DrawX (CDC* pDC, CRect* pRect)
{
    //
    // Make a local copy of the rectangle and shrink it.
    //
    CRect rect;
    rect.CopyRect (pRect);
    rect.DeflateRect (10, 10);

    //
    // Create a red pen and use it to draw an X.
    //
    CPen pen (PS_SOLID, 10, RGB (255, 0, 0));
    CPen* pOldPen = pDC->SelectObject (&pen);

    pDC->MoveTo (rect.left, rect.top);
    pDC->LineTo (rect.right, rect.bottom);
    pDC->MoveTo (rect.left, rect.bottom);
    pDC->LineTo (rect.right, rect.top);

    pDC->SelectObject (pOldPen);
}
```

```
void CTicView::DrawO (CDC* pDC, CRect* pRect)
{
    //
    // Make a local copy of the rectangle and shrink it.
    //
    CRect rect;
    rect.CopyRect (pRect);
    rect.DeflateRect (10, 10);

    //
    // Create a blue pen and use it to draw an O.
    //
    CPen pen (PS_SOLID, 10, RGB (0, 0, 255));
    CPen* pOldPen = pDC->SelectObject (&pen);
    pDC->SelectStockObject (NULL_BRUSH);

    pDC->Ellipse (rect);

    pDC->SelectObject (pOldPen);
}
```

FIGURE 2: *The view class's DrawX and DrawO functions.*

and draws an O using MFC's CDC::Ellipse function:

```
pDC->Ellipse (rect);
```

In both cases, the pen is selected into the device context with CDC::SelectObject before anything is drawn and selected back out when drawing is complete:

```
CPen* pOldPen = pDC->SelectObject
(&pen);
   .
   .
   .
pDC->SelectObject (pOldPen);
```

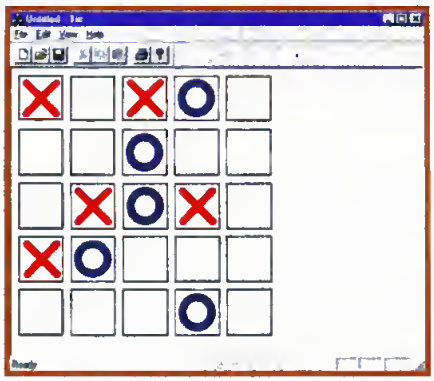


FIGURE 3: *Finally, X's and O's!*

CPen is the MFC class that represents GDI pens—logical objects used to draw lines and curves. Unless a pen is selected into a device context, LineTo, Ellipse, and other CDC functions use the device context's default pen, which draws black lines just 1 pixel wide. When you select a pen or other GDI object into a device context, you should select it back out before the CDC object representing the device context is deleted or allowed to go out of scope. In order to select a pen out of a device context, you must select another pen in. That's why both DrawX and DrawO save the CPen pointer returned by SelectObject. That pointer identifies the pen that was previously selected into the device context. Passing the pointer back to SelectObject before the function ends selects the default pen back into the device context and deselects the CPen that was selected earlier.

When CDC::Ellipse draws a circle or ellipse, it borders the figure with the pen that's currently selected into the device context, and fills the figure's interior with the current brush. A *brush* is a GDI object that's used to paint pixels on a display surface. Like a pen, it must be selected into a device context before functions such as CDC::Ellipse will use it. We want our O to be drawn with a hollow interior, so before calling CDC::Ellipse, the view's DrawO function selects a NULL brush—which draws nothing—into the device context with the following statement:

```
pDC->SelectStockObject
(NULL_BRUSH);
```

NULL_BRUSH is one of several supplied drawing objects that an application can select into a device context with CDC::SelectStockObject. DrawO doesn't bother to deselect the brush from the device context after drawing is complete, because with stock objects, unlike conventional drawing objects, that isn't necessary.

After you add the DrawX and DrawO functions shown in Figure 2 to the view, rebuild the application and test it by clicking a

```
void CTicView::OnDraw(CDC* pDC)
{
    CTicDoc* pDoc = GetDocument();
    ASSERT_VALID(pDoc);

    //
    // Set the mapping mode to MM_LOENGLISH,
    // where 1 unit = 0.01 inch.
    //
    pDC->SetMapMode (MM_LOENGLISH);

    //
    // Draw the playing grid.
    //
    for (int i=0; i<5; i++) {
        for (int j=0; j<5; j++) {
            pDC->Rectangle (m_rect[i][j]);
            BYTE bVal = pDoc->GetSquare (i, j);
            if (bVal == 1) // Draw an X
                DrawX (pDC, &m_rect[i][j]);
            else if (bVal == 2) // Draw an O
                DrawO (pDC, &m_rect[i][j]);
        }
    }
}
```

FIGURE 4: *The finished OnDraw function.*

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few squares with the left mouse button. Clicking an empty square should produce a red X or a blue O (see Figure 3). Clicking a square that already contains an X or O should do nothing.

There's still one small problem, though. To demonstrate, add a few X's and O's to the playing grid and then minimize the window. When you restore the window, the X's and O's will have vanished. What happened? Simple: We modifed OnLButtonDown to draw X's and O's in response to mouse clicks, but we still need to update the view's OnDraw handler to draw the X's and O's when the view is repainted. The infrastructure is already in place, because we can use the document's GetSquare function to determine what, if anything, each square contains, and we can use the DrawX and DrawO functions that we've already written to do the drawing.

UPDATING THE ONDRAW FUNCTION

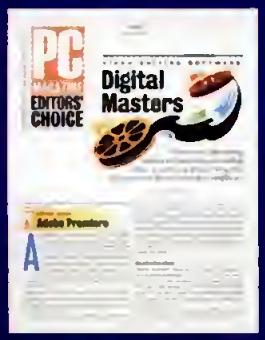
Figure 4 shows the updated OnDraw function. Formerly, the nested `for` loop that iterates through the squares simply redrew the squares by calling CDC::Rectangle. Now it redraws the squares and calls DrawX or DrawO when CTicDoc::GetSquare returns a nonzero value. After updating OnDraw as shown, test it by drawing some X's and O's and then minimizing and restoring the window to force the application to repaint. The window should come back up looking just as it did before it was minimized.

At long last, we have a working application! In fact, it's probably nearer completion than you realize. For example, the New command in the File menu works even though we haven't explicitly written any code for it. Try it. Choose New from the File menu to erase any X's and O's currently displayed in the grid. It works, because MFC provides a handler for the File | New command that indirectly calls our document's OnNewDocument function. Recall from the past issue that CTicDoc::OnNewDocument zeroes out all the squares in the grid. After our OnNewDocument code is executed, MFC invalidates the view to force a repaint. Then, when the view's OnDraw function is called, it draws empty squares. The Print and Print Preview commands work, too, both courtesy of MFC.

In the next installment of this column, we'll finish up our application by adding code to make the File menu's Open, Save, and Save As commands functional. We'll let MFC do the bulk of the work, so our job will be surprisingly easy. □

Jeff Prosise is a contributing editor of PC Magazine *and the author of* Programming Windows 95 with MFC, *published by Microsoft Press.*

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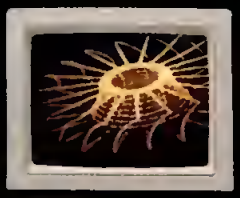
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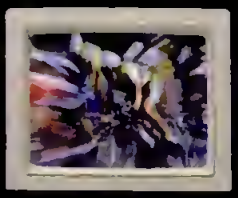
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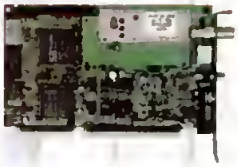
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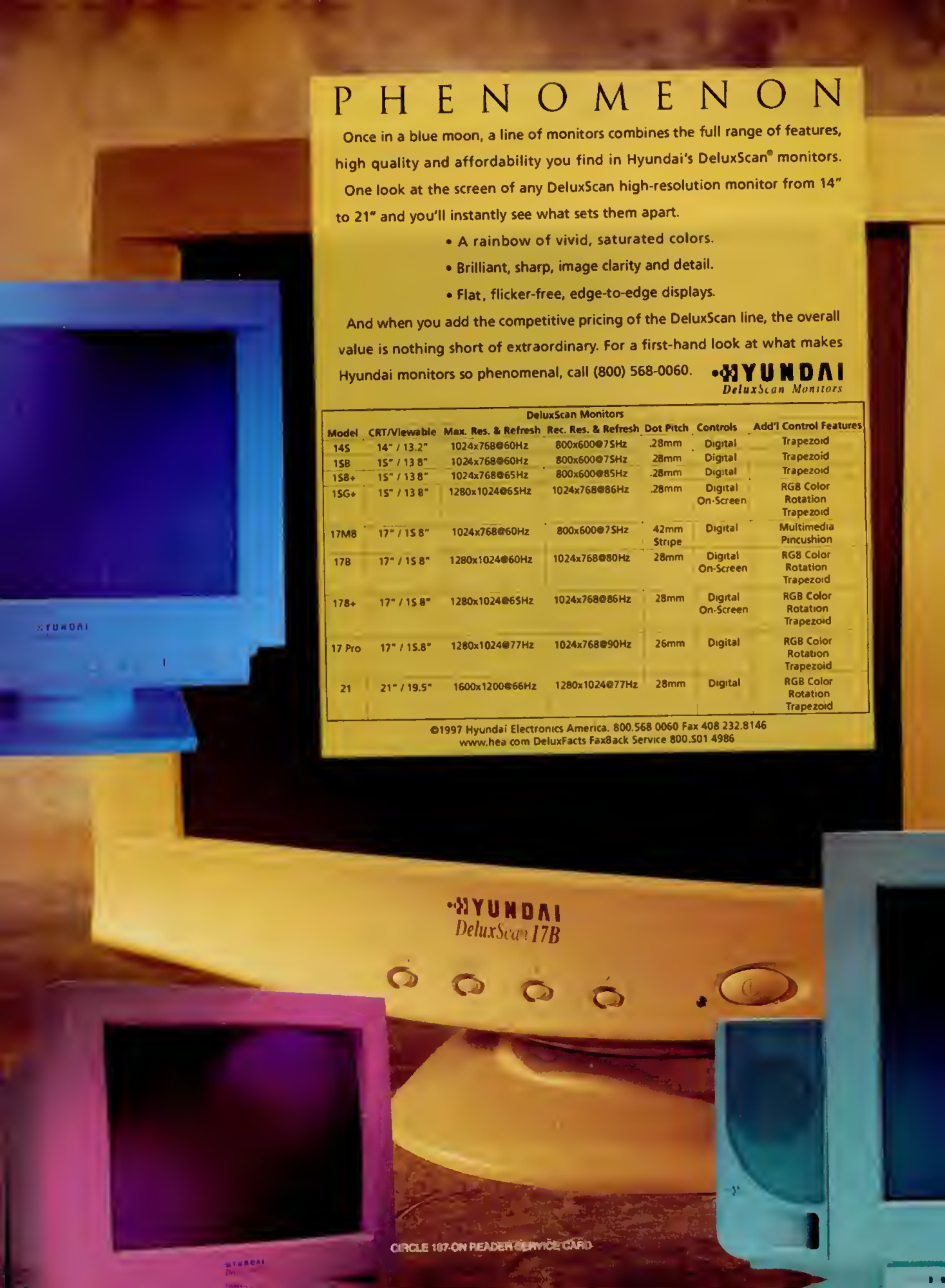
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17B+	17" / 15.8"	1280x1024@65Hz	1024x768@86Hz	.28mm	Digital On-Screen	RGB Color Rotation Trapezoid
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By Zan Oliphant

Telnet and Windows 95

A bare-bones client shows you how to develop telnet applications.

Telnet was introduced in the early 1980s as a generalized, 8-bit, bidirectional method of communication between a *virtual terminal device* and a computer. A virtual terminal device is different from a nonvirtual terminal, also known as a *dumb terminal*. As personal computer prices go down, dumb terminals are harder to find. Many of them are just a screen and keyboard with a serial interface to a computer. PCs, with local processors, memory, and disk storage, are much more versatile and are rapidly replacing dumb terminals. About ten years ago, when I worked at a Unix-based computer manufacturer, only upper management got their own PCs, while the rest of us were stuck with terminals connected at 9,600 bits per second. Those lucky PC users were running a DOS version of telnet to connect to the Unix hosts.

Telnet is not limited to Unix. Most multiuser computers have some sort of telnet server. The idea behind telnet is to provide a generic interface to any computer on a TCP/IP-based network, regardless of hardware or operating system. Telnet was originally specified in the Internet Requests for Comments (RFCs) 854 through 861. (An RFC is one of thousands of documents that specify the protocols and policies of the Internet. You might check out *www.uwaterloo.ca/uw_infoserv/rfc.html* for a good listing of RFCs.)

In today's world, the Internet is a huge, worldwide TCP/IP network with millions of computers attached to it. Many of these computers are Web servers that store files for Web pages on the Internet. Some happy person, commonly called a Webmaster, has to manage the files for a given Web page. Many of those Webmasters are using telnet in conjunction with File Transfer Protocol (FTP) to manage their Web files. A common Web-page management scenario is to use FTP for uploading files (images, HTML, and so on) and telnet for server file system management tasks like creating directories or deleting files. Though some Web presence providers allow only FTP access, most give telnet access also.

With the tremendous popularity of the Web today, you can see why telnet is becoming better known in the PC world. Good evidence of this is the large number of telnet clients for Windows systems.

This article will show you how to write a line-mode telnet client for Windows 95 using Windows Sockets (Winsock), the most popular TCP/IP interface on the Windows platform. Windows sockets are derived from Berkeley sockets, introduced in 1984 with the Berkeley Software Distribution version (4.2BSD) of Unix. (You can read more about sockets in "Windows-to-Unix Sockets," *PC Magazine*, February 18, 1997.)

The example covered in this article breaks from traditional Windows programming by using console mode. A console-mode program is a Win32 application that looks identical to a DOS command line application. The example uses 32-bit Windows API functions to handle threads for both socket and keyboard interfaces. With multiple threads, we can avoid using an event-driven window for handling I/O, as was popular for Windows 3.*x* programming. Additionally, removing extra code required for graphical windows allows us to concentrate on the telnet protocol.

THE PROTOCOL

Unlike FTP, where separate connections are established for control and data, telnet works with a single TCP connection for both user data and control. By *control*, I mean data sequences that have special meaning to either the client or server outside of the normal data flow. Because the telnet protocol interlaces control commands with data, telnet commands must be preceded with a special escape character, called *Interpret as Command* (IAC). When either the telnet client or the server sees an IAC (defined as decimal 255) in the data stream, a parser retrieves further control functions. (Decimal 255 can be sent with no special meaning by preceding it with an IAC.)

The telnet command structure minimally consists of 2 bytes. The first is always the escape character, IAC. The second is a high-level telnet command. RFC 854 defines these commands as shown in the table below. You can read up on them in RFC 854.

Many of the commands are self-evident. But one group requires some explanation. These are the *option commands*, and if you look at the command list, you'll see there are four of them: WILL, WON'T, DO, and DON'T. Telnet options, the heart of any telnet implementation, allow the negotiation of things like terminal type, binary mode, echo, and terminal speed, and they are handled in a special way. (There are too many options to list here; check out RFC 856 through 861 for more.)

TELNET COMMANDS

Command	Decimal	Meaning
SE	240	End of subnegotiation.
NOP	241	No operation.
Data Mark	242	The data stream portion of a Synch.
Break	243	Network virtual terminal BRK character.
Interrupt Process	244	Interrupt current process.
Abort Output	245	Abort output without killing process.
Are You There	246	Show that the connection is alive
Erase Character	247	Delete preceding character.
Erase Line	248	Delete current line.
Go Ahead	249	Request for input (for half-duplex connections).
SB	250	Start of subnegotiation
WILL*	251	Offer to begin performing option (or confirm that you are performing option)
WON'T*	252	Refuse to perform (or continue performing) option.
DO*	253	Request that the other party perform option (or confirm you are expecting the other party to perform option).
DON'T*	254	Demand that the other party stop performing option (or confirm that you no longer expect the other party to perform option).

* An option command.



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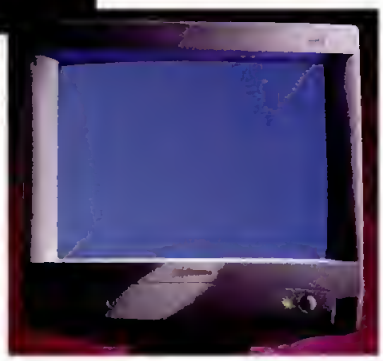
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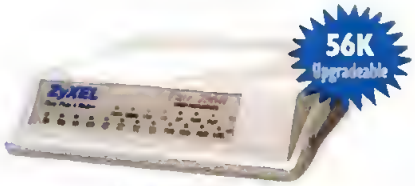
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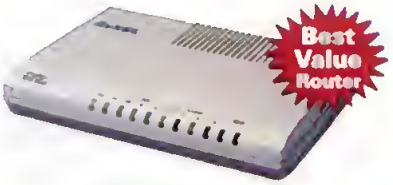
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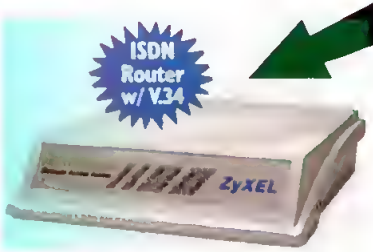
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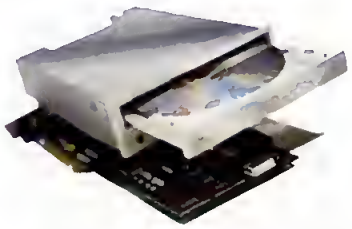


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Unlike other telnet commands, telnet options require a 3-byte sequence: IAC, followed by option command, followed by an option code, which references the type of option. Option commands can be sent by either party in the protocol. The meaning of an option command depends on whether it is being used to initiate or respond to a request. The WILL and WON'T commands, for example, indicate an offer to begin or an intention to stop performing an option when they are used to initiate a dialog. The opposite party would respond either with DO, for confirmation—"by all means, perform the option you've offered to do"—or with DON'T. Conversely, DO or DON'T, when used first, indicate a request for the other party to perform or stop performing an option; they are acknowledged with WILL, for confirmation—"okay, I'll perform the option you've asked me to do"—or WON'T. To prevent an endless loop, a few rules apply. First, you may request *only a change in option status.* Don't send a DO just to announce what mode you're in. Second, if you receive a request to enter a mode that you're already in, the request should not be acknowledged.

In this column, we will look at processing telnet options for a bare-bones telnet implementation. Again, make sure to read the aforementioned RFCs for more information.

THE SAMPLE CODE

You can get the source code for this sample from PC Magazine Online. This sample is a skeleton for a telnet implementation, meant as a learning tool and not as a truly usable telnet program. You can use what you learn from this article to create your own telnet program or perhaps add telnet capability to a Windows program.

Need a real telnet? Windows 95 ships with Microsoft Telnet, located in the Windows directory as Telnet.exe. Also, there are plenty of Winsock telnet programs available as shareware for both Windows 3.1 and Windows 95. The source code discussed in this article produces a Windows 95 console-mode program that uses 32-bit Winsock for a line-mode version of telnet.

The first thing the example program does, after checking command line parameters, is to start Windows Sockets. Here we request Winsock, Version 1.1, by specifying a 1 in both the high and low bytes of a Windows WORD:

```
WORD  wVersion = MAKEWORD(1,1);
WSADATA  wsaData;

// Start Windows Sockets

WSAStartup (wVersion, &wsaData);
```

Winsock implementation data is returned in the wsaData structure. Our sample doesn't look at that structure, as it contains version information along with other socket information that we don't need to be concerned about.

Next, the code gets an IP address for the telnet host name, passed in as the program's first argument:

```
// Get IP Address

if (!(ph = gethostbyname (argv[1])))
{
printf ("Can't get host: %s\n",
argv[1]);
exit(1);
}
```

It's important to note here that the call to `gethostbyname()` will not return until the pointer to the host entry structure is returned containing the resolved IP address. Though not a big problem with a console-mode Windows 95 program, a window-based application should preferably use `WSAAsyncGetHostByName()`. This Winsock API function is asynchronous and will not block, but you need a window to use it, which is why our console-mode application doesn't.

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Notice that the parameters AF_INET, SOCK_STREAM, and IPPROTO_TCP are used to indicate the Internet address family, a streaming connection–oriented socket, and TCP protocol, respectively:

```
// Create the socket

SOCKET  s;

if ((s = socket (AF_INET, SOCK_STREAM,
IPPROTO_TCP)) < 0)
{
        printf ("Socket Error\n");
exit(-1);
}
```

Now we need to bind the newly created socket with a local address. A call to the Winsock API function `bind()` requires a pointer to a SOCKADDR_IN structure, which must contain the address family, local address, and local port. In this example, we specify a family of AF_INET and let Winsock fill in our local address and port by putting INADDR_ANY for `sin_addr.s_addr` and 0 for `sin_port`.

```
SOCKADDR_INServerAddr;

memset ((char *)&ServerAddr, 0,
sizeof(ServerAddr));
ServerAddr.sin_family = AF_INET;
ServerAddr.sin_addr.s_addr =
htonl(INADDR_ANY);
ServerAddr.sin_port = 0;

bind (s, (struct sockaddr
*)&ServerAddr, sizeof(ServerAddr));
```

Next, we reuse the `ServerAddr` structure for a call to the Winsock API `connect()`, which establishes a connection to the telnet host that was specified in the command line. Notice the family is again AF_INET. The address is taken from the results of our previous call to `gethostbyname()`, which had returned a pointer to a `hostent` structure. Port 23 is used for `sin_port` in network byte order with a call to `htons()`. Port 23 is called a reserved port and is always used for telnet.

```
// Connect to UNIX
ServerAddr.sin_family= AF_INET;
ServerAddr.sin_addr.S_un.S_un_b.s_b1
 = ph->h_addr[0];
ServerAddr.sin_addr.S_un.S_un_b.s_b2
 = ph->h_addr[1];
ServerAddr.sin_addr.S_un.S_un_b.s_b3
 = ph->h_addr[2];
 ServerAddr.sin_addr.S_un.S_un_b.s_b4
 = ph->h_addr[3];
// Port 23 is for Telnet
ServerAddr.sin_port= htons(23);

if ((rc = connect (s,
 (struct sockaddr *)&ServerAddr,
 sizeof(ServerAddr))) < 0)
{
   printf ("Connect Error\n");
   exit(-1);
}
```

Again you should know that a call to `connect()` will block for an undetermined amount of time. As an alternative in a non-console application, consider using `WSAAsyncSelect()` with FD_CONNECT to avoid any blocking. Our sample simply waits for a connection.

Once a connection is established, the sample creates a separate thread to handle user input with a call to `CreateThread()`. This Win32 API function creates another thread of execution within the same process. Why another thread? Using two threads (the first being the main application thread) allows one thread to block as it waits for data from the socket connection while the other thread blocks for user input. This technique, not possible in DOS-based Windows 3.1, avoids using the Winsock asynchronous extensions (prefaced with WSA) that I have been mentioning



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as alternatives. In our example, the thread is created with the default stack size, a starting address called `KeyBoardThread()`, and the parameter of the socket descriptor for that routine. The thread ID is returned in `dwThreadID`, and the handle is returned to `hThread`:

```
// Create an input thread
DWORD dwThreadID;

HANDLE hThread = CreateThread  (NULL,
   0, LPTHREAD_START_ROUTINE);
   KeyBoardThread, (void *)s, 0,
   &dwThreadID);
```

After the input thread is created, the code enters a loop calling the Winsock API function `recv()` and parsing the received data with a call to our routine `ParseTelnetData()`. The `recv()` function is called with the socket descriptor, input buffer, input buffer length, and flags:

```
// Enter receive loop
while (cnt && (cnt != SOCKET_ERROR))
{
   cnt = recv (s, InBuff,
          sizeof(InBuff), 0);
   ParseTelnetData (InBuff, cnt, s);
}
```

The number of bytes received is returned to `cnt`, if no error occurred. A value of `SOCKET_ERROR` is returned to indicate an error. If the connection has been gracefully closed, a value of 0 is returned. Either value will end the `while` loop. `ParseTelnetData()` also checks for these values to avoid processing invalid data.

The `ParseTelnetData()` function is available for download from PC Magazine Online. Within this routine are two global values maintained to track special telnet commands and options. These are `ucIAC` and `ucTelnetCommand`. They maintain the previous IAC character or command option and must be saved in case a command sequence is broken up between `recv()` calls.

`ParseTelnetData()` begins processing the data chunk by entering a `for` loop to process each byte of data. Within that loop, a previous telnet command is identified by looking at `ucTelnetCommand`. Our simple telnet implementation only looks at the DO, DON'T, WILL, and WON'T commands, as defined in this C code by DOTEL, DONTTEL, WILLTEL, and WONTTEL. The example, a *really* dumb telnet, will only respond to one DO option, and that is Suppress Go Ahead (SGA). The telnet Go Ahead character was designed for use with half-duplex connections—it's like saying "over" after speaking on a two-way radio. Since our connection is full-duplex, we avoid the complexity of the Go Ahead character (decimal 249) by suppressing it. Any other DO requests are responded to with a WON'T. DON'T, WILL, and WON'T are simply ignored.

If there was no previous command, the next thing looked for is a previous IAC character. As we noted, IAC stands for *Interpret as Command* and indicates the start of a telnet command sequence. The sample code ignores all commands except for DO, DON'T, WILL, and WON'T. Other commands are included in the code as comments for future implementation. Notice that a double IAC passes through as an escaped character, though this code does nothing with it.

The third `else if` statement in the `ParseTelnetData()` function looks for the actual IAC. The `else if` statements are in reverse time order, as it's easier to code that way. By reverse time order, I mean that the bottom of the loop checks for the attention character (IAC), the middle of the loop checks for the command, and the top checks for the command's option (if any). If the last `else if` statement is not TRUE, the code enters a final `else` to handle regular telnet stream data. Here, after making sure the character is printable, a call to `putchar()` is made to print the character on the console.

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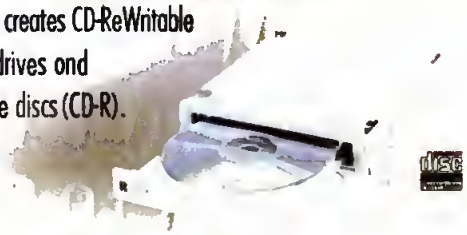


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MEANWHILE, BACK IN THE THREAD...

Earlier, we created another thread with a starting routine called `KeyBoardThread()`, whose main duty is to read keystrokes from the keyboard by blocking on the `_getch()` Win32 library call. When `_getch()` returns, a value of 0x1b (ESC) causes the program to terminate. Calls to `closesocket()`, `WSACleanup()`, and `ExitProcess()` are made for that termination. The call to `ExitProcess()` will also ensure that thread 1 is ended.

Provided that Esc was not pressed, the character is sent to the telnet host by a call to Winsock `send()`, with socket descriptor, buffer, buffer length, and special flags:

```
// KeyBoardThread
//
int KeyBoardThread (SOCKET s)
{
   char ch;
   while (ch = _getch())
   {
      if (ch == 0x1b)
      {
         closesocket (s);
         WSACleanup();
         ExitProcess (0);
      }
      send (s, &ch, 1, 0);
   }
   return 0;
}
```

As you can see, here we are using `send()`, but before, in the `ParseTelnetData()` function, `sendn()` was used. Why? Windows Sockets documentation states, "On nonblocking stream-oriented sockets, the number of bytes written can be between 1 and the requested length, depending on buffer availability on both the local and foreign hosts." `KeyBoardThread()` always writes a single byte, whereas in `ParseTelnetData()`, 3 bytes are written, making it necessary for a special routine called `sendn()` to ensure that all 3 bytes are actually written:

```
// sendn
//
int sendn (SOCKET socket, char *ptr,
int nbytes)
{
   int   nleft, nwritten;

   nleft = nbytes;

   while (nleft > 0)
   {
      nwritten = send (socket, ptr,
      nbytes, 0);
      if (nwritten <= 0)   /* error */
      {
         return nwritten;
      }
      nleft -= nwritten;
      ptr += nwritten;
   }
   return (nbytes - nleft);
}
```

RUNNING IT

There's not much to say about running the application. Using a DOS command prompt, type:

```
zantel hostname
```

where `hostname` is the name of a telnet host, like *login.com*. It may take a while to get to a log-on prompt, depending on your connection. Once logged on, you should be able to execute any line-mode commands. Screen-oriented programs that require a full-screen terminal type, such as a VT-100, will not work correctly. To exit the program, hit Esc or just log off. □

Zan Oliphant is president of Zan Software, maker of ZanNet, a Windows 95 network client and Unix server designed for Webmasters. He is also the author of Programming Netscape Plug-ins *(Sams.net Publishing). You can reach Zan via e-mail at* zan@gate.net.



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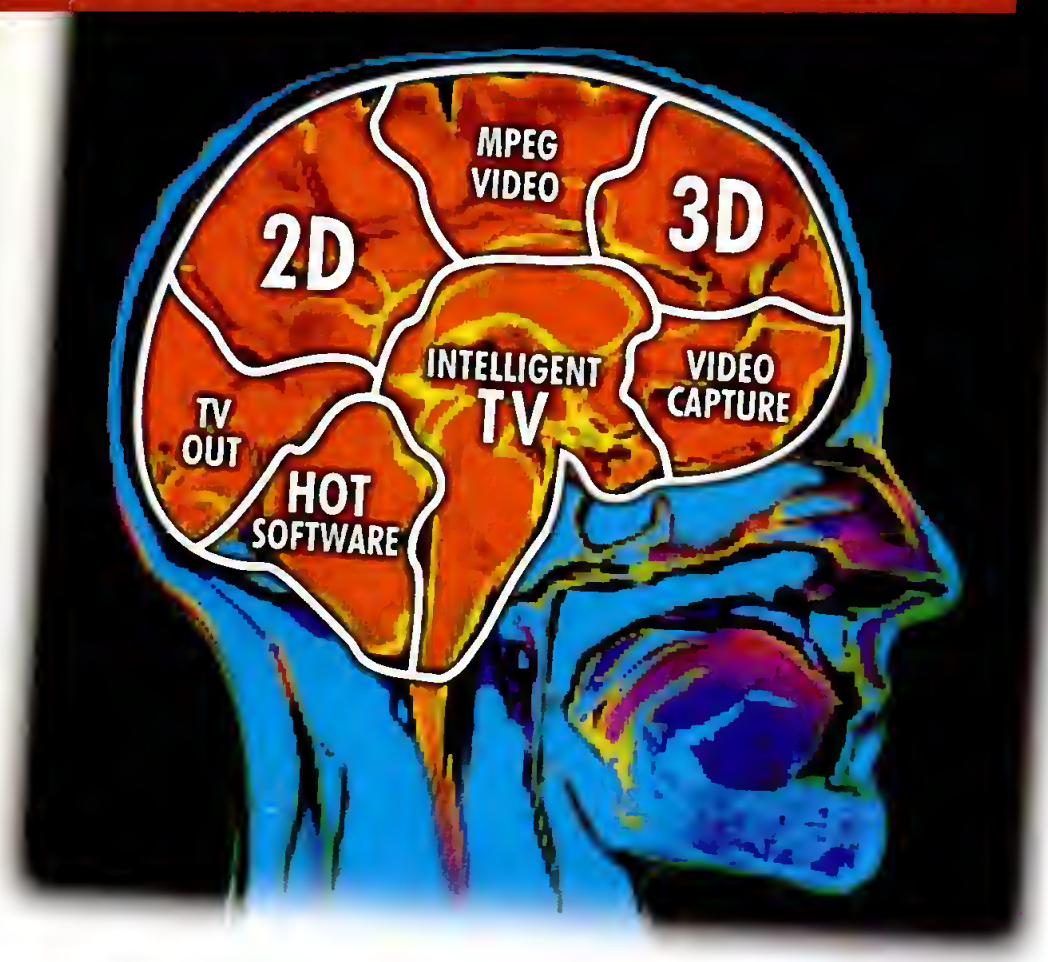
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By James C. Collins

Beyond CGI: Using the APIs

Alternatives for adding interactive power to your Web site.

For its intended purpose—page description—HTML is just fine. But when you need customized features like guest books, access counters, or online ordering, HTML doesn't offer much help. Those features must be implemented on the server, where they are not built-in. The most common way to extend HTML is through CGI (Common Gateway Interface), but most servers also have hooks that let you extend HTML's ability to interact with browsers.

CGI scripts are programs executed by the server in response to user actions. (For an overview, see "How the Common Gateway Interface Works," *PC Magazine*, September 24, 1996.) CGI lets Webmasters add common features, such as counters and date/time displays, online order forms, chat pages, and search engines.

CGI is popular for several reasons. Many prewritten scripts are freely available, the majority of them for a variety of platforms and for most of the popular Web servers. But CGI has several drawbacks. Each time a CGI script is spawned, it creates an additional process on the server machine, slowing the server's response time. Also, if the CGI script is not set up correctly, security holes can occur on the server, rendering the Web site vulnerable to attacks by hackers. Another problem is that it is difficult to *maintain state*—that is, to preserve information about the client from one HTTP request to the next.

An alternative to modifying or extending the abilities of the server is to use its *application programming interface* (API). The API allows the developer to modify the server's default behavior and give it new capabilities. When a server's default behavior is modified—for example, in logging transactions—the server uses the code in an API module instead of its own built-in code. When functionality is added to a server—such as database access—the API acts as an interface between the server and another application.

Whether modifying or extending server functionality this way, a developer doesn't have to recompile the server code. (With CGI, you must add additional code and recompile and relink the server code.)

In addition to addressing some of the drawbacks of CGI, the use of an API offers other features and benefits, such as the ability to share data and communications resources with a server, the ability to share function libraries, and additional capabilities in authentication and error handling. Another advantage of API applications is their ability to maintain state. Because an API application remains in memory between client requests, information about a client can be stored and used again when the client makes another request.

There are, however, some drawbacks to this approach. Unlike CGI, API functions are server-specific, because each server has a different API. Buggy API code can crash a server. And more complexity is involved in developing the code, which must manage multiple process threads and clean up memory after it is run.

In this article we will concentrate primarily on two server vendors' APIs, those for use with Netscape's servers and Microsoft's Internet Information Server. We will not discuss the exact specifics of developing API functions for each type of server. That information is provided in the documentation accompanying the server software.

NSAPI SERVER DIRECTIVES

Directive	Action
InitTrans	Instantiates a shared resource on server start-up
AuthTrans	Authenticates users
NameTrans	Handles redirection
PathCheck	Validates user's permission to access the requested files
ObjectType	Encompasses functions dealing with MIME types
Service	Responds to client requests, such as POST or GET
AddLog	Logs transactions
Error	Handles errors

FIGURE 1: *Each NSAPI server directive corresponds to one of the request-processing steps used by the Netscape server, and each API function is associated with a directive.*

THE NETSCAPE SERVER API

Because you are essentially extending the server's code, familiarity with how the server responds to requests is a prerequisite. Knowledge of the data structures and public functions you'll use to interface with the server is essential. Netscape has provided documentation for these issues on its Web site, and we will discuss them briefly here.

When the server starts, it searches the Windows Registry for the API object files and loads each in turn. Under Windows NT, these object files are DLL files. The functions in them are categorized by the types of requests they respond to. In the Netscape server model, a client sends a request to the server and the server sends a response. The response process involves several steps. In order, they are:

- authorization translation,
- name translation,
- path checking,
- object type checking (handling MIME types),
- sending a response to a client, and
- logging a transaction.

Implementing each of these steps involves what Netscape terms *server application functions*, which an NSAPI application modifies or replaces. The function categories are located in the NSAPI in one of eight server directives, shown in Figure 1. Each directive corresponds to one of the request-processing steps outlined above, and each function is associated with a directive. The Netscape servers come with sample C code demonstrating how the default behavior for each directive can be changed.

Netscape API DLLs can be written in any language that allows the creation of DLLs, including C, C++, and Delphi. The actual creation of an NSAPI application is beyond the scope of this article, but we can look at the installation process common to most NSAPI applications.

Once an API program has been com iled

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scape server will be aware of it. This is done in HKEY_LOCAL_MACHINE\Software\Netscape\Httpd-80\CurrentVersion\Startup. Using RegEdit, you can add new keys and values specific to the API application. After modifying the Registry, reboot the server. If the API application has been written and installed correctly, the new functions should now be active.

If the process seems complicated, that's because it is. If you need to extend the default server functionality and you don't require anything too esoteric, several third-party solutions are available that give you the benefits of using NSAPI while eliminating the do-it-yourself parts. Two of the most common needs are database access and redirection. (We'll discuss products that meet those needs in the following section. More solutions are discussed later.) You can find detailed information on NSAPI at *home.netscape.com/newsref/std/server_api.html.*

DATABASE ACCESS AND REDIRECTION

Spider Technologies' NetDynamics, a *PC Magazine* Editors' Choice ("Web Database Tools," September 10, 1996), uses an application server to cache database requests. NetDynamics interfaces directly with a Netscape Web server through an optimized NSAPI interface, avoiding the need for handwritten code. A page wizard guides the developer through the design of the database interface. The actual engine is Java-based, but that part is invisible to the developer. HTML code to interface with the engine is generated by the application. An evaluation version is available for downloading from the company's Web site (*www.netdynamics.com*), along with ample documentation and examples of the NetDynamics engine in use.

For redirection, look to Switcheroo, from Nu Tech Software Solutions. It allows redirection based on client browser type (called *content negotiation*). That means you can send clients using Netscape browsers to one page, clients using Internet Explorer to another, and clients using other browsers to yet a third page. You can also intercept requests for pages that have been renamed or moved and redirect clients to the appropriate pages. Switcheroo uses NSAPI to interface with the server and provides full support for multiple domains.

A complete list of products using the NSAPI is available at *cgi.netscape.com/comprod/server_central/server_add_ons.html.*

THE MICROSOFT INTERNET SERVER API

Using Microsoft's Internet Server API (ISAPI), the API application interacts with the server through an *extension control block* (ECB), a data structure that contains information about how the API processes a request. When a server calls an application and passes an ECB, the application uses the GetServerVariable and the ReadClient functions to read client input. After processing the input, the application uses the WriteClient function to send data back to the client and then calls the ServerSupportFunction to tell the server it has finished processing the request. ISAPI applications are installed using the Internet Service Manager.

The ISAPI consists of two types of server extensions, termed *filters* and *applications.* Filters process, set up, or change requests before a server receives them, and they are called with every client request. Filter DLLs are referenced in the Registry and are accessed by the server upon start-up. Applications, however, must be requested by a client. For example, an application called Foo.dll would be invoked by *http://www.mysite.com/foo.dll?action=go.*

In addition to the ISAPI, the OLEISAPI allows your API extension to interface with OLE (Object Linking and Embedding) Automation servers. This provides a way for developers using Visual Basic to interface with the ISAPI. (ISAPI development requires either Visual C++ or Delphi.) The OLEISAPI is a subset of the ISAPI and is not officially supported by Microsoft. An excellent OLEISAPI site is located at *www.datawide.com/oleisapi.*

An interesting alternative for Visual Basic developers is provided by a company called classTools (*www.classtools.com*). One classTools product, webAction, provides an interface by which VB can access ISAPI functionality and offers runtime debugging. A fully functional demo version is available from the company's Web site.

For more information about ISAPI in general, Stephen Genusa maintains an excellent site at *www.isapideveloper.net.* It contains specifications, an FAQ, lots of source code, and links to ISAPI consultants. And don't ignore the official Microsoft ISAPI site: *www.microsoft.com/win32dev/apiext/isapimrg.htm.*

COMPARISON OF THE TWO APIs

NSAPI gives developers a finer level of control by allowing functions to work on various levels, such as authentication, forms processing, error handling, and logging. But developer resources are poor if you haven't joined Netscape's developer program. The sample code that comes with the server is Unix-oriented, and the documentation has the typical Unix terseness. We were unable to find any independent Web sites devoted to NSAPI development, and we found only one public-domain NSAPI application with source code (NSNVBITF, discussed below).

By contrast, there is a plethora of documentation for Microsoft's ISAPI interface. Genusa's site should provide even a beginner with enough information and examples to start developing ISAPI applications, and Microsoft's site has an abundance of well-written, easy-to-understand documentation.

Regarding the learning curve required to develop server-side applications, Microsoft's ISAPI seems more straightforward, and the abundance of developer resources is a big help.

OTHER ALTERNATIVES

Several third-party tools let you add functionality to a server without the complexity of programming to an API. Here is a brief look at several of these.

Denali is the code name for Microsoft's ActiveX scripting environment for its Internet Information Server. Although still in beta at the time of this writing, Microsoft has indicated that Denali will provide server-side compiled scripts for fast execution. Denali will offer native support for VBScript and JavaScript along with support for other scripting languages, such as Perl, Python, and REXX, through Active Scripting plug-ins. It will also support ActiveX components. Included in Denali is support for state mantainence, database access, and content negotiation. Using content negotiation, a server can determine whether a browser has support for a particular feature, such as frames, and can offer alternative representations of the output. Microsoft's Web site offers more information about Denali, at *www.microsoft.com/infoserv.*

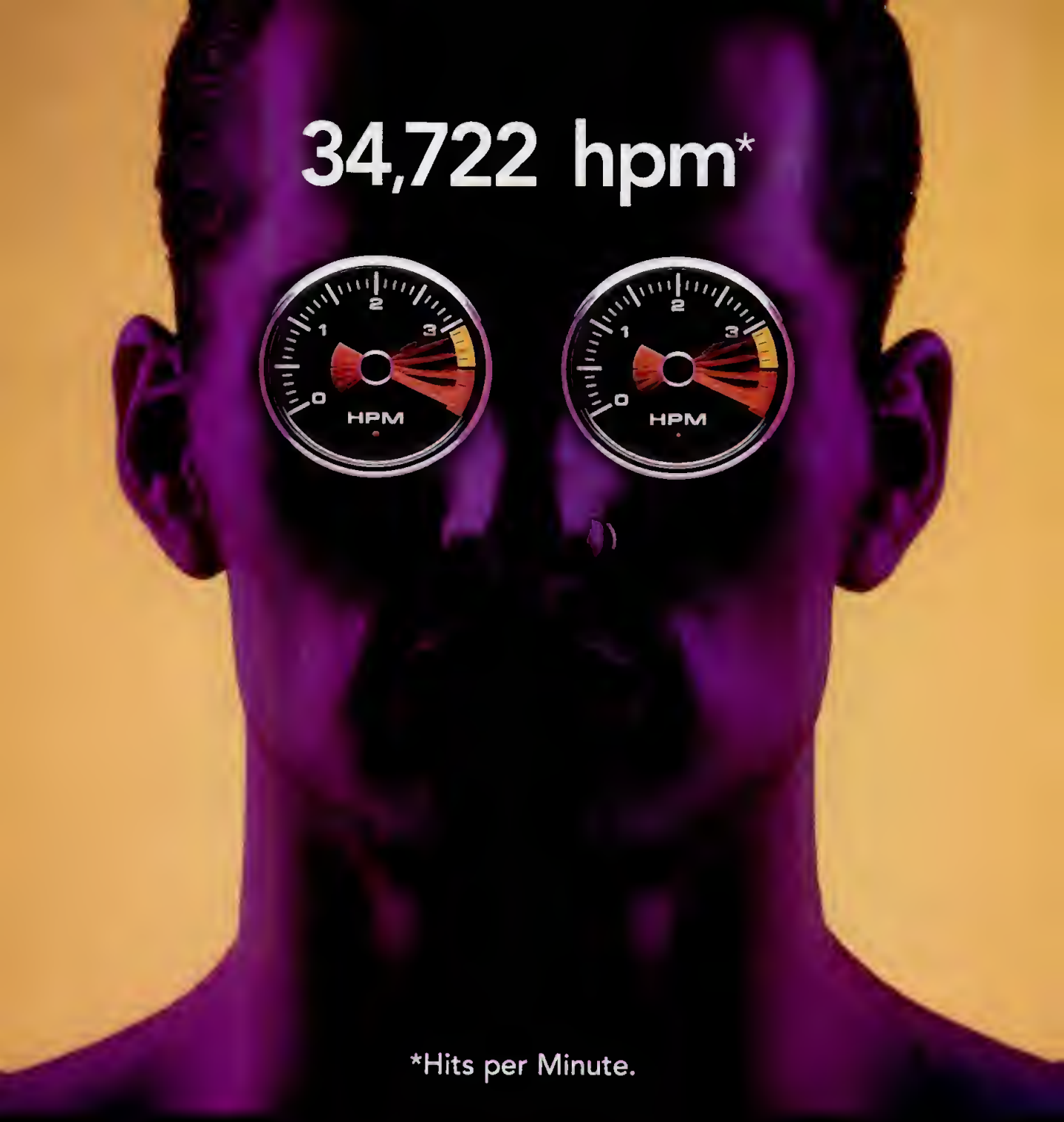
FastCGI has been developed by Open Market to allow developers to continue to use CGI applications with the added benefits of a server API. Using the FastCGI interface, CGI applications are loaded once and continue to be resident. In this way, the performance problem of the load-run-unload model is avoided. FastCGI is an elegant compromise between CGI and API development. FastCGI is compatible with all Web servers. More information is available at *www.fastcgi.com.*

NSNVBITF, a DLL written by Steve Caine of Caine, Farber & Gordon, allows applications written in Visual Basic 3.0 to access the Netscape OLE Automation Object. NSNVBITF is public-domain and freely redistributable, and it comes with complete source code. It is available at *www1.cfg.com/vb/nsnvbitf/nsapi.html.*

Life.com's **VBCode** allows you to build Visual Basic 4.0 applications that interface directly to a server. Life.com also makes other server extension products that interface with server APIs. VBCode works with Microsoft, Netscape, and O'Reilly servers. More information is available at *www.lifecom.com.*

iHTML, by Inline Information Services, is a set of HTML extensions that are interpreted and acted on by the iHTML DLL, which is connected directly to a server as an API application. iHTML offers more than 30 new HTML functions, including ODBC support and 20 environment variables. iHTML runs on Windows NT with Microsoft, Netscape, and Process Web servers. A test version is available for download from *www.ihtml.com.* □

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Sun microsystems

By Neil J. Rubenking

Go Crazy with LogoMania!

Design a replacement for the Windows 95 animated logo.

When you start Windows 95, you see a background of clouds, over which floats the Windows 95 logo. Blue and gray color bars pulse across the bottom of the screen so you won't think the computer is frozen. But why should you gaze at a Microsoft logo every time your computer starts? LogoMania lets you replace the standard logo with your own animated logo bitmap. You can float your company's logo over a hypnotic moving background, like the *PC Magazine* logo in Figure 1, or put a color-changing company name in front of a serene mountain landscape.

LogoMania lets you keep the animated and static portions of the image in separate bitmaps, which it merges for you. LogoMania will take care of adjusting your input bitmaps to the correct size and correct number of colors, if necessary. It will even create animated backgrounds, wild or subtle, for you. Once you've created a Windows 95 animated logo bitmap, you can preview it without leaving LogoMania.

You can obtain LogoMania by downloading it from PC Magazine Online or by mail. (Refer to the sidebar "Getting the Files" for details.) The source code for LogoMania, which was written with Delphi 2.0, Borland's visual programming tool, is also provided for those interested in seeing how it works.

HOW LOGOMANIA WORKS

Windows 95 creates the illusion of animation in its start-up and shutdown logos using an old technique known as *palette animation*. To explain how this works, I need to start with some background on Windows bitmaps.

A Windows bitmap file starts with a header that includes handy information, such as the picture's width and height in pixels, and it ends with a huge chunk of data that lists the color of every pixel in the picture. A 256-color bitmap has a palette—a list of up to 256 colors, expressed as combinations of red, green, and blue values from 0 to 255—in its header. Each pixel in the image is represented by a 1-byte index into the palette. That way, a bitmap can include a wide variety of colors yet still require just a single byte to store each pixel.

When Windows 95 animates a logo bitmap, it doesn't change the pixels at all. Instead, it changes the palette. Suppose palette-entry 255 contains bright red, and we change that entry to bright green. All of the pixels that use entry number 255 will instantly change from red to green. Windows 95's logo animation simply involves cycling a set of adjacent palette entries, starting with the last entry (number 255) and working down. Windows 95 repeatedly moves the contents of each palette entry that's involved in animation into the next lower entry and moves the contents of the lowest animation palette entry into the last entry. For example, let's say that palette entries 253, 254, and 255 contain the colors yellow, green, and blue, respectively. After the first frame of animation, entry 253 gets the color from entry 254, 254 gets the contents of 255, and 255 gets the previous contents of 253. Slots 253, 254, and 255 now contain green, blue, and yellow, respectively. After the second frame of animation, they contain blue, yellow, and green. As the cycle repeats, it *looks* as though the colors are moving from right to left. LogoMania lets you create bitmaps that Windows can animate using this technique.

IN THIS ISSUE

LogoMania

LogoMania lets you replace the standard Windows 95 logo and its cloudy background with your own personalized animated logo bitmap.



USING LOGOMANIA

To install LogoMania, copy the files Logomani.exe, Logomani.hlp, and Logomani.cnt to a directory on your hard disk. You may wish to place a shortcut to Logomani.exe in one of your Start menu folders. To uninstall LogoMania, delete the three files you originally copied to your hard disk, along with Logomani.ini, Logomani.gid, and Logomani.fts (if WinHelp has created the last two files, that is).

To create an animated logo bitmap, you start with a bitmap that includes just the animated part. You can optionally add a second bitmap defining the non-animated parts. From your bitmaps, LogoMania will build a new composite bitmap with the particular internal structure required for a Windows 95 animated logo bitmap.

CREATING THE ANIMATION BITMAP

The first step in creating an animated logo bitmap is to select or generate the animation bitmap; LogoMania's Animation bitmap pageAnimation_bitmap_page contains tools to do this. You have three choices:

- Choose an existing bitmap and, if necessary, force it to the size required by LogoMania.
- Let LogoMania generate an animated background for you by clicking the Generate button.

FOR PROGRAMMERS ONLY LogoMania deals mainly with bitmaps and palettes, but it doesn't make any serious use of the Delphi TBitmap object or of the bitmap-handling facilities supplied by Windows. To obtain the control it needs, LogoMania manipulates the bitmaps as data files, without translating them into images on the screen. The source code for LogoMania demonstrates

- how to read and write bitmaps by working directly with bitmap files;
- how to reduce the number of colors in a bitmap's palette; and
- how to create bitmap files from mathematical formulas.

SUPPORT Help for *PC Magazine*'s free utilities can be obtained in our online discussion areas, both on the World Wide Web (*www.pcmag.com/discuss.htm*) and, on ZD Net, in the Utilities section of ZD Net's TIPS Forum (GO ZNT:TIPS). The authors of current utilities generally visit this forum daily. You may find an answer to your question simply by reading the messages posted in the forum. If the author is not available and the forum sysops can't answer your question, the Utilities column editor, who also checks this forum each day, will contact the author for you.

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FIGURE 1: *In this animated logo bitmap, which was created using LogoMania, yellow and blue circles expand behind the* PC Magazine *logo.*

• Use Windows Paint to create the animation bitmap.

The first two options are by far the easiest and can produce striking results. If you want to create your animation bitmap from scratch using Windows Paint, you'll find instructions for doing so in LogoMania's online help.

When you first launch LogoMania, you'll see the Animation bitmap page (see Figure 2). Click the Choose button to select a bitmap, which must be 256-color and must have the standard extension .BMP. If you want to use a bitmap that isn't 256-color, you must first load the file into Windows Paint, select Save As, and save it as a 256-color bitmap.

Once the bitmap is loaded, the Details button is enabled; click this button for detailed information about the bitmap. A reduced-size thumbnail view of the bitmap will be displayed for reference.

Every Windows 95 animated logo bitmap must be precisely 320 by 400 pixels in size. (Upon display, Windows 95 stretches it to 640-by-400.) The same size restriction applies to LogoMania's animation and static bitmaps. If the selected bitmap is not 320-by-400, LogoMania will enable the Tile/Chop button. Click it to save a new version of the bitmap at the correct size. A bitmap that's too small will be tiled to fill the space, while one that's too large will be chopped to the correct size. If the bitmap is smaller than 640-by-400, the Center button will be enabled. Click it to create a 320-by-400 bitmap, with the existing bitmap centered horizontally and vertically. The area surrounding the centered bitmap is set to an arbitrary color, which you can change with Windows Paint.

When the loaded bitmap is 320-by-400, the Tile/Chop and Center buttons will be disabled and LogoMania will scan all the pixels in the bitmap, counting how many are assigned to each palette color. At this time, the Palette button is enabled. Clicking it brings up the Palette Adjustment form, which lets you change the colors associated with each palette entry in use. Adjusting the palette isn't normally required, but it allows advanced users to achieve impressive animation effects. (See the program's online help for details.)

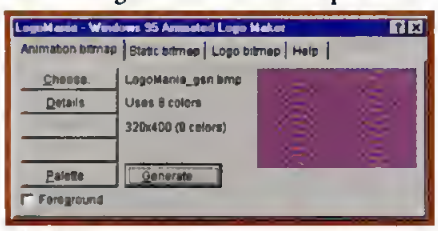


FIGURE 2: *An animated logo bitmap always starts with a bitmap defining just the animated part of the image. An optional static bitmap defines non-animated parts.*

The background in Figure 1 was produced by LogoMania's Animated Background Generator form (see Figure 3), which you can access by clicking on the Generate button on the Animation bitmap page. Three of the controls on this form determine the pattern that will be used to fill the bitmap, which also has an effect on animation characteristics. Shape defines the overall pattern, such as circle, square, or stripe. Direction is the direction of apparent motion when the bitmap is animated. And for most shapes, a larger width produces a coarser pattern with faster apparent motion.

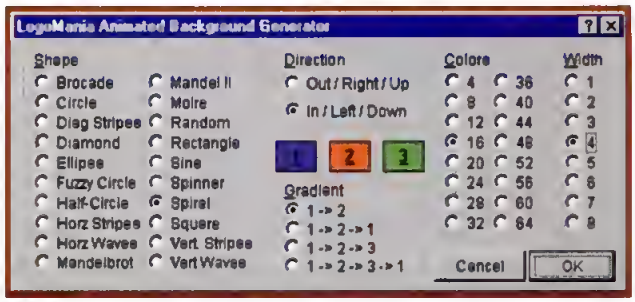


FIGURE 3: *LogoMania's animated background generator can produce thousands of different animated background bitmaps.*

The remaining controls in the Generator dialog box define the color palette that will be used. Click one of the three color boxes or press Alt-1, Alt-2, or Alt-3 to set the fixed colors. Choose the number of colors you want LogoMania to generate and select one of the four gradient styles:

1→2	Shades smoothly from color 1 to color 2.
1→2→1	Shades from color 1 to color 2 and back to color 1.
1→2→3	Shades from color 1 to color 2 and then to color 3.
1→2→3→1	Shades from color 1 to color 2 to color 3 and back to color 1.

Almost any combination of option settings will produce an interesting background. Feel free to experiment. LogoMania will remember the most recent settings you used in the Animated Background Generator form, so you can easily come back and fine-tune your background bitmap. The bitmap created using this form is always stored as LogoMania_Gen.bmp, in the same directory as the application. If you produce a totally awesome background that you want to save for future use, just copy or rename LogoMania_Gen.bmp.

CREATING THE STATIC BITMAP

Static bitmaps can be placed in the foreground or the background; you can use any bitmap you like. Figure 1 shows a static bitmap of the *PC Magazine* logo floating in the foreground over an animated background. Static backgrounds give a different effect. For example, you could select a scanned photo as the background and float a color-changing animation bitmap over it. The static bitmap is optional; if you omit it, LogoMania will produce a 100 percent animated logo bitmap.

Like the animation bitmap, the static bitmap must be a 320-by-400 image. You can select a bitmap on the Static bitmap page and let LogoMania tile or chop it to fit the required size, or you can resize the image yourself using Windows Paint. Use the Stretch/Skew option from the Image menu in Windows Paint to get the image close to 640-by-400, then set the Image Attributes to 640-by-400. Now use Stretch/Skew one final time to reduce the bitmap's width by 50 percent.

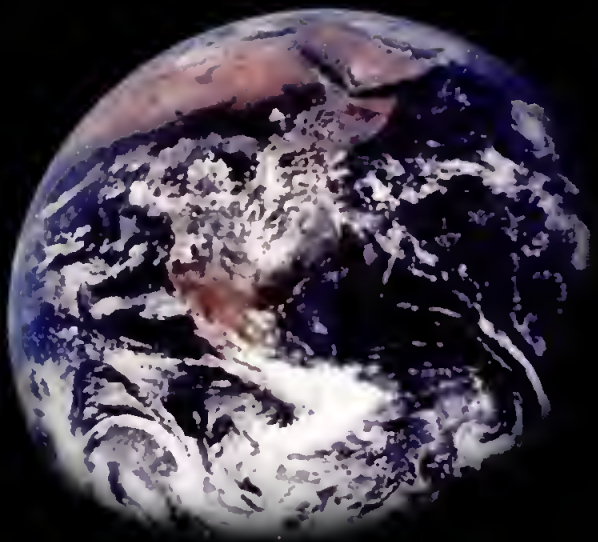
The animated logo bitmap generated by LogoMania can have at most 256 different colors, so the total number of colors used by the animation and static bitmaps can't exceed 256. If the static bitmap uses too many colors, LogoMania will enable the Fewer Colors button. The edit box next to the button controls how many colors will be used; its maximum is 256 minus the number of colors in the animation bitmap. If the color-reduced image is muddy or indistinct, consider using an animation bitmap with fewer colors.

FOREGROUND AND BACKGROUND

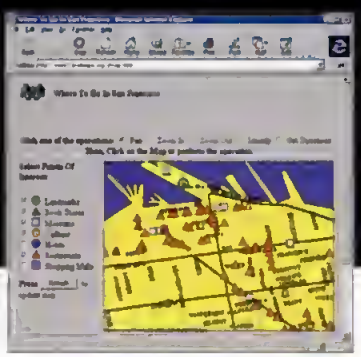
The animation bitmap page and the static bitmap page both have check boxes labeled Foreground. Checking one of these automatically unchecks the other. When LogoMania merges the two bitmaps, it looks at

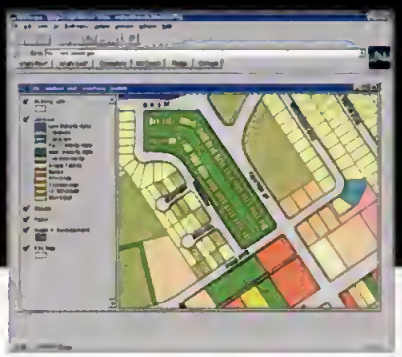
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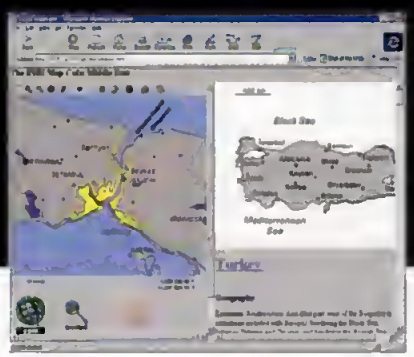
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```
TYPE
  PalSortType = record
    OrgIndex, NewIndex          : Byte;
    pstRed, pstGreen, pstBlue   : Byte;
    Pixels                      : Integer;
  end;
VAR PalSort : ARRAY[0..255] OF PalSortType;
  ...

  procedure ReduceColors;
  VAR
    X, CloseX, OneDist, ClosestDist : Integer;
    Swaptemp                        : PalSortType;

    function DistFrom(A, B : PalSortType) : Integer;
    begin
      Result := Abs(A.pstRed   - B.pstRed) +
        Abs(A.pstGreen - B.pstGreen) + Abs(A.pstBlue  -
        B.pstBlue);
    end;

  begin
    WHILE SlotsUsed > SlotMax DO
      begin
        ClosestDist := 3*255;
        CloseX  := SlotsUsed-1;
        // slots are in order of prevalence; from
        // SlotsUsed
        // to 255 they are all zero. Search downward
        // seeking
        // closest color match.
        FOR X := SlotsUsed-2 DOWNTO 0 DO
          begin
            OneDist := DistFrom(PalSort[SlotsUsed-1],
            PalSort[X]);
            IF OneDist < ClosestDist THEN
              begin
                ClosestDist := OneDist;
                CloseX  := X;
              end;
          end;
        // add the last item's pixel-count to the closest
        // one
        Inc(PalSort[CloseX].Pixels, PalSort[SlotsUsed-
        1].Pixels);
        // zero out the last item's pixel-count
        PalSort[SlotsUsed-1].Pixels := 0;
        // set the last item to be replaced by the
        // closest
        PalSort[SlotsUsed-1].NewIndex :=
        PalSort[CloseX].OrgIndex;
        // the closest item now has more pixels; to
        // maintain the
        // sorted order it may need to move lower in the
        // list
        X := CloseX-1;
        WHILE (X > 0) AND
          (PalSort[X].Pixels < PalSort[CloseX].Pixels) DO
          Dec(X);
        Inc(X);
        IF PalSort[X].Pixels < PalSort[CloseX].Pixels
        THEN
          begin
            SwapTemp        := PalSort[CloseX];
            PalSort[CloseX] := PalSort[X];
            PalSort[X]      := SwapTemp;
          end;
        // some of the now-unused colors may have their
        // new index
        // set to the color we just replaced; change them
        // to point
        // to the color by which it was replaced
        FOR X := SlotsUsed TO 255 DO
          IF PalSort[X].NewIndex = PalSort[SlotsUsed-
          1].OrgIndex THEN
            PalSort[X].NewIndex :=
            PalSort[CloseX].OrgIndex;
        Dec(SlotsUsed);
      end;
  end;
```

FIGURE 4: *In order to reduce the number of colors a bitmap uses, LogoMania's ReduceColors procedure uses the PalSort array to find the least used colors and merge them with the in-use colors that are closest to them.*

the pixel in the bottom-left corner of the foreground bitmap and treats all pixels of that color as transparent. Each pixel in the final image is copied from the corresponding pixel in either the foreground or background bitmap. If the foreground pixel matches the transparent color, the background pixel is copied; if not, the foreground pixel is copied.

In Figure 1, the static bitmap of the *PC Magazine* logo consists of white letters in a red rectangle, centered on a white field. Since the bottom-left pixel of the foreground bitmap is white, all white pixels are treated as transparent, allowing the animated background to show through around and within the logo.

The Foreground check box serves a purpose even when you are not using a static bitmap. When not checked, all colors in the image will be animated. When checked, the transparent color will not be animated. If you've centered a bitmap on a single-color background, you'll want to check the Foreground box. Otherwise, the background will flash wildly as the bitmap animates.

CREATING THE ANIMATED LOGO

Once you have selected an animation and (optionally) a static bitmap, flip to the Logo bitmap page, click the Create button, and save the animated logo bitmap. If the resulting reduced-size thumbnail view looks totally wrong, you may have put the wrong bitmap in the foreground; toggle the value of the Foreground check box on either the Animation bitmap page or the Static bitmap page and click Create again.

If the Create button is not enabled, it means something is wrong with at least one of your bitmap selections. The possibilities are:

- No animation bitmap has been selected.
- The animation bitmap is not 320-by-400.
- The animation bitmap is 320-by-400, but the static bitmap is not.
- Both the animation bitmap and the static bitmap are 320-by-400, but the total number of colors used by the two is greater than 256. Correct the problem and try again.

As long as your system is running in 256-color mode, the Preview button will be enabled any time an animated logo bitmap has been created or loaded. Click this button for a preview of the logo being animated the same way that Windows 95 will animate it at start-up. If your system's display adapter and drivers support changing video resolution on the fly, the Preview at 640x400 check box will be enabled. Checking this box before pressing Preview causes

LogoMania to display the logo animation at 640-by-400 resolution, giving a very accurate preview.

ACTIVATING THE ANIMATED LOGO

If the file LOGO.SYS is present in the root directory of the boot drive, Windows 95 loads it as the animated logo bitmap. To install your own animated logo, copy it to the root directory of the boot drive. Then rename LOGO.SYS (if present) to LOGO.OLD, and rename your new logo to LOGO.SYS. Note that the two screens that Windows 95 displays at shutdown are also 320-by-400 bitmaps. The one that asks you to wait while Windows 95 shuts down is LOGOW.SYS; the one that informs you that it's safe to sbut the computer off is LOGOS.SYS. Both reside in the Windows 95 directory. You can use any bitmap that has been sized by LogoMania in place of either of the supplied shutdown bitmaps.

I've described the basics of using LogoMania, but a few minutes spent working through the tutorials in the help system will be wortb your while. LogoMania isn't difficult to use, but its features go deeper than might be apparent at first. Remember that you can get help for each page of the main form and for each helper form by pressing F1. Also, to get help for an individual component, you can click on the help icon on the title bar and then click on the component.

PROGRAMMING LOGOMANIA

LogoMania deals mainly with bitmaps and palettes, but it doesn't make any serious use of the Delphi TBitmap object or of the bitmap-handling facilities supplied by Windows. The problem is that Windows attempts to share the palette fairly among all open windows, while LogoMania needs total control of the palette. It gets this control by manipulating the bitmaps as data files without translating them into on-screen images. The only major feature that does use the Windows palette system is the palette animation in preview mode. In the section below, I'll discuss these high points of LogoMania's programming:

- reading and writing bitmaps by working directly with bitmap files;
- reducing the number of colors in a bitmap's palette; and
- creating bitmap files from mathematical formulas.

THE BITMAP FILE STRUCTURE

Every 256-color Windows bitmap file consists of the same four parts: a bitmap file header (TBitmapFileHeader in Delphi), a bitmap info header (TBitmapInfoHeader in Delphi), a table of colors defining the palette used by the bitmap, and the actual bitmap data, which is stored as rows of pixels starting with the bottom line.

In the TBitmapInfoHeader, the biWidth and biHeight fields define the size of the bitmap in pixels, and the biPlanes and biBitCount fields indicate the number of bits per pixel. In a 256-color bitmap, biPlanes is always 1 and biBitCount is 8. The biClrUsed field tells how many colors the palette uses, with 0 signifying tbe full complement of 256. Last is the biClrImportant field, which is normally used only by the Windows palette manager.

Windows 95 color-shifts only a portion of the palette. That's how it's able to display some parts of the logo as static and some parts as animated. In an animated logo bitmap, the biClrImportant field represents the index of the first animation palette entry. Windows 95 will cycle the colors from that entry to entry number 255. If you try to edit the Windows 95 default LOGO.SYS using Windows Paint, you'll find that it no longer animates after you save it. Why? Because Paint has set the biClrImportant field to 0.

> LogoMania isn't difficult to use, but its features go deeper than might be apparent at first.

THE RED OF PROCRUSTES

The mythical giant Procrustes had a bed that was always the right size: If his guests were too sbort, he stretched them to fit; if they were too tall, he cut off the extra bits. LogoMania takes a similar approach in producing a bitmap. First it builds a TBitmapFileHeader and TBitmapInfoHeader that describe a 256-color, 320-by-400 bitmap. LogoMania copies the palette from tbe original bitmap, expands it to 256 colors if necessary, then determines whether to adjust the bitmap's aspect ratio by doubling the height or halving the width. Remember, at display time Windows 95 stretches the bitmap to twice its actual width. If the bitmap is smaller than 320-by-200, LogoMania doubles the height; otherwise, it halves the width.

After writing the header data to the output file, LogoMania builds the output image one row of pixels at a time. The program repeatedly reads a line of pixels from the input file, builds an output line, and writes it to the output file. If LogoMania is balving the image's width, it skips every other pixel in the input file; if doubling the image's height, it writes each row of pixels twice. An input line longer than 320 pixels is truncated to 320 pixels. If shorter, the input line is repeated until 320 pixels have been filled. In the same way, if there are more than 200 rows of pixels in the input file, rows after the two hundredth one are ignored. If there are fewer, the lines are repeated to make 200 rows. Because the first row of pixel data in the file represents the last row in the image, LogoMania reads and writes the rows of pixel data starting from the last row in the file and working back toward the first.

When the bitmap is smaller than 640-by-400, LogoMania will optionally center it rather than tiling or truncating it. This is a similar process, again beginning with the creation of a bitmap file header, bitmap info header, and palette for the output file. LogoMania writes as many blank lines as necessary to center the image vertically, then centers each line of pixels horizontally.

COLOR REDUCTION

Naturally, a 256-color bitmap can't use more than 256 colors. If the total number of palette entries used by pixels in the animation bitmap and the static bitmap is greater than 256, LogoMania offers to reduce the number of colors in the static bitmap. Frequently, this is accomplished with no apparent loss of image quality. The greater the reduction, however, the greater tbe chance that the resulting image will be fuzzy or unclear. I'll describe the technique here and show part of its source code; for the full source code, see the SaveWithReducedColors method in the Logomanu.pas unit.

LogoMania starts the color-reduction process by locating and combining any palette entries that define the same RGB color. After that, it attempts to minimize the impact of its color reduction by always changing the color that's used by the fewest pixels. It changes all pixels using the just-removed color to the color in use that comes closest to matching it.

Rather than search all 128,000 pixels for those affected by each palette color change, LogoMania builds a translation table that maps palette entries from the original bitmap to the reduced-color bitmap. It uses an array called PalSort, containing 256 user-defined PalSortType structures (see Figure 4), each of which stores the red, green, and blue color components of the corresponding entry in the original bitmap's palette, along with the number of pixels that use that entry. (The pixel count is already available, because LogoMania had to take a pixel census in order to determine how many different colors are used.) PalSortType also includes the fields OrgIndex (the palette index from the original bitmap) and NewIndex (tbe palette index to be used in the new bitmap); NewIndex is initially the same as OrgIndex.

If any two items in the PalSort array have the same color values, LogoMania combines them. The program sets the pixel count of

one of them (call it A) to the sum of the pixel counts of both, then sets the pixel count of the other item (call it B) to 0, and the NewIndex field to the OrgIndex of item A. Next, LogoMania sorts the array in descending order by the number of pixels used by each entry. The transparent color, if there is one, gets special treatment. It is put in the second palette entry, regardless of the number of pixels used.

Figure 4 shows the ReduceColors function, in which LogoMania repeatedly takes the least used entry, locates the in-use entry closest to it, and merges the two. That is, LogoMania assigns the total pixel count of both entries to the closest-match entry, sets the pixel count of the least used entry to 0, and sets the NewIndex of the least used entry to the OrgIndex of the closest-match entry. The closest-match entry now has a larger pixel count than it did before, so the ReduceColors function moves it to a new position in the sorted array, if necessary. It continues until the number of colors has been reduced as much as necessary.

To create the translation table, LogoMania sorts the array on the OrgIndex field (the palette index in the original bitmap), restoring the original order. The program builds the translation table from the NewIndex field of each entry, and it writes the new file's bitmap file header, bitmap info header, and palette. Then it copies each line of pixel data from the old file to the new, replacing each pixel with the corresponding value from the translation table. The result is a new bitmap that is very much like the old but uses fewer colors.

CREATING THE LOGO BITMAP

The Create button on the Logo bitmap page is not enabled unless you have chosen a 320-by-400 animation bitmap and either no static bitmap or a 320-by-400 static bitmap with the correct number of colors. These constraints make it fairly easy for LogoMania to create an animated logo bitmap. It starts by building a palette from the palettes of the two input bitmaps. It copies palette entries from the static bitmap to the new palette, starting from entry 0 and working upward, copying only entries that are used by at least one pixel. In the same way, LogoMania copies the animation bitmap's in-use palette entries to the new palette, starting from entry 255 and working down. The next step is to write a bitmap file header and bitmap info header, as usual, with the biClrImportant field of the bitmap info header set to the index of the first palette entry taken from the animation bitmap.

To create the bitmap data portion of the animated logo bitmap, LogoMania repeatedly reads a line of pixels from the animation bitmap and the static bitmap. It copies pixels from one or the other of these lines using this rule: If the foreground bitmap's pixel matches the transparent color, copy the background bitmap's pixel; if not, copy the foreground bitmap's pixel.

Creating an animated logo bitmap from an animation bitmap alone (without a static bitmap) is even easier. No merging of pixel information is required. The only difference is that if the animation bitmap's Foreground box is checked, LogoMania places the transparent color in the non-animated portion of the palette. If not, it leaves all of the animation bitmap's colors in the animated portion.

GENERATING ANIMATED BITMAPS

LogoMania's Animated Background Generator can produce thousands of different animated backgrounds based on simple mathematical formulas. To create the illusion of animation, it builds the gradient-fill palette by setting from two to four fixed palette entries and then interpolating RGB values between them. LogoMania writes the bitmap headers and palette as usual and then calculates the color to be used for each pixel.

The ColorFunc function determines the color of each pixel using the selected shape formula and other options that are passed to it as parameters. The vRow and vCol parameters represent the pixels' location, and the vGenT parameter defines which of the 20 formulas should be used. The vIsIn parameter is True if the animation direction is In/Left/Down and False if it's Out/Right/Up, vColors is the number of colors to be used, and vWid represents line width (in most cases).

Let's look at a simple example, the formula for diagonal stripes:

```
Result := (((vCol*2+vRow) DIV vWid)
MOD vColors);
```

This formula produces a series of diagonal stripes that cycle through all available colors; their width is controlled by the vWid parameter. All the formulas are similar to this one. They perform some calculation involving the pixel row and column, taking into account the fact that Windows 95 will double the bitmap's width. Most of them divide the result by vWid to control width in some way, and then they use the MOD operator to force the result into the range from 0 to vColors-1. If you have Delphi, you can modify the source code to add formulas of your own.

I started programming LogoMania with the idea that I would use Delphi's handy support for reading and displaying bitmaps. After some experimentation, I discovered I needed more control, which forced me to manipulate the bitmaps as data files, not as images. It was an interesting evolution, and the results speak for themselves. □

Neil J. Rubenking is contributing technical editor of PC Magazine.

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PC Solutions

TIPS AND TECHNIQUES TO INCREASE YOUR PRODUCTIVITY

User-to-User

By Neil J. Rubenking

Restoring DOS After Upgrading to Win 95

Most solutions for setting up dual-booting between Windows 95 and DOS assume you retained your old DOS when installing Windows 95. If you removed DOS when installing Windows 95 or if your system never had DOS installed to begin with, you can still set up dual-booting, though the process is tedious. Once dual-booting is working, you can even install Windows 3.x after booting under DOS. Of course, you must specify a location for Windows 3.x other than the Windows 95 folder, and if Windows Setup ever needs to restart the machine, you'd have to be sure to boot DOS at each restart. The two Windows setups are completely independent of each other. To run Windows 3.1x, you just boot under DOS first.

The following procedure lets you add a minimal dual-boot configuration. To start, you must have a DOS 5.x or better boot disk in the A: drive. Open a DOS window and enter

```
C:
CD \
MD OLD_DOS
COPY A:\IO.SYS IO.DOS
COPY A:\MSDOS.SYS MSDOS.DOS
COPY A:\COMMAND.COM COMMAND.DOS
COPY COMMAND.DOS OLD_DOS\COMMAND.COM
```

Now open a text editor, such as MS-DOS EDIT or Notepad, and create a file named C:\CONFIG.DOS containing the single line

```
SHELL=C:\OLD_DOS\COMMAND.COM
C:\OLD_DOS /P
```

Then create a file named C:\AUTOEXEC.DOS with these three lines:

```
@ECHO OFF
PATH C:\OLD_DOS
PROMPT $P$G
```

Make a backup copy of C:\MSDOS.SYS, which should already exist. (You may first have to use either ATTRIB or Explorer to clear the Hidden/System/Read-Only attributes.) Then edit the [Options] section of the file, adding the line "BootMulti=1." If a line exists that reads "BootKeys=0," change that to "BootKeys=1."

You should now be able to boot to DOS by restarting your machine and pressing F4 when the Starting Windows 95 message appears. Of course, this will be a bare-bones configuration; the only commands available are those internal to COMMAND.COM. When you want to start Windows, reboot without pressing F4.

Expanding your DOS configuration is the tedious part. You can install all the executables and so forth from the DOS distribution disks to the C:\OLD_DOS directory and then modify CONFIG.DOS and AUTOEXEC.DOS as appropriate to add any device drivers and TSRs you want to use under DOS. If you choose to edit these files under old DOS, use their regular names, CONFIG.SYS and AUTOEXEC.BAT, and do not touch any files with the extension .W40. You must not run DOS's SETUP program or use the SYS command, or you risk blowing away Windows 95's start-up files.

The basics of this procedure (where to copy the old DOS system files and what to name them) is outlined in the Windows Resource Kit. It even covers other DOS versions (such as PC-DOS) that may use different names for system files. The only limiting factor appears to be that your old DOS version must be new enough for it not to care about the physical location of the DOS kernel (MSDOS.SYS, IBMDOS.COM, and so on). For MS-DOS, this means Version 5.0 or later.

GREG WOLKING
via ZD Net

PC MAGAZINE: If you installed Windows 95 over your old DOS and Windows, you can also regain the ability to dual-boot into DOS by following these steps: Install your old DOS using its SETUP disk (this will destroy your ability to boot into Windows 95). Now, install Windows 3.1. Finally, reinstall Windows 95, making sure to avoid replacing your old DOS and Windows this time.

Although this procedure seems simpler, reinstalling Windows 95 is immensely time-consuming. Not only that, parts of the specific Windows 95 setup you've developed by installing your favorite programs may be overwritten by the reinstallation. Thus, the process described above may actually be a better alternative. It may take a number of fiddly little steps, but your existing Windows 95 installation will remain intact.

HIGHLIGHTS



HARDWARE The Windows 95 start-up disk is certainly useful, but it may not be able to do all that you think it can. *Page 370.*



SPREADSHEETS Corel Office is not as well integrated as it might be: We look at incompatible date values between WordPerfect and Quattro Pro. *Page 382.*



DATABASES A couple of tools that make it easier to manipulate the data in your Microsoft Access database. *Page 382.*

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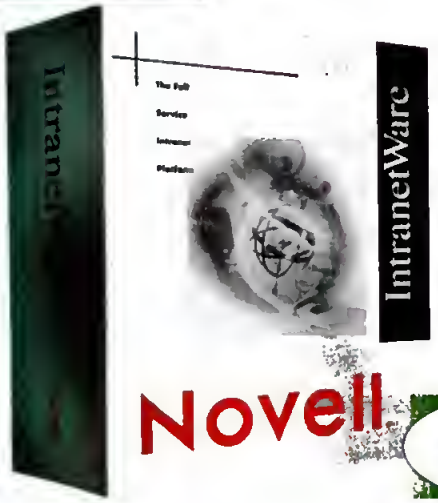


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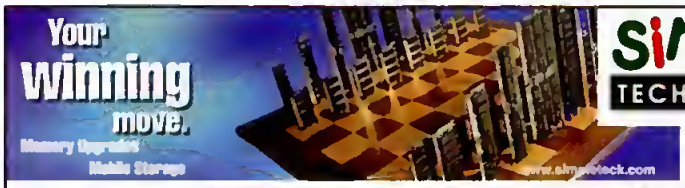
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HARDWARE

Disk Disaster



When you create a Windows 95 start-up disk, the program prompts imply the disk will let you recover from a hard disk failure. The disk created on my system, however, does not load the necessary drivers to access my CD-ROM or Zip drives in the event that my hard disk fails, so I can't get at my backups or my Windows 95 CD-ROM in order to reinstall the software. Do I misunderstand the purpose of the start-up disk? Can you tell me how to figure out which files I need on a boot disk so I can access my Win 95 CD?

PETER ALEXANDER
via the Internet

PC MAGAZINE: You make an excellent point. The Windows 95 start-up disk is handy, but it only works if your hard disk is still working well enough for you to access files on it. This is fine if your problem is that something has gone wrong with the boot files or that the configuration has become damaged to the point where Windows won't load, but the start-up disk does not provide sufficient protection in the event of a major meltdown. Fortunately, you can add a few files to compensate for this shortcoming.

First, let's look at what the start-up disk does include. It has Command.com and the hidden system files required to make the disk bootable. It also includes the standard disk utilities you'd need to make a hard disk bootable: Fdisk, Format, and Sys. You also get Scandisk and Chkdsk to check the condition of the file system, and Edit and RegEdit to alter configuration files and the Registry. Finally, you get Attrib, Drvspace.bin, Debug, and Uninstal for good measure.

What you don't get are Autoexec.bat and Config.sys files, or any of the real-mode drivers some of your computer's devices, such as CD-ROM drives, may require.

If you have upgraded this system from older versions of DOS and Windows, or if you have set up your DOS-mode configuration files, you may be able to add the required files easily. Look for Autoexec.dos and Config.dos in the root directory of your boot drive. Copy these as Autoexec.bat and Config.sys to your start-up disk and edit them to remove hard disk paths from the system and driver files referenced. Then, for each of the lines you changed, copy the referenced files from the hard disk to the start-up disk.

If you don't have the DOS-mode configuration files, you'll need to create them from scratch. To access your CD-ROM drive, you will have to add at least two lines: a reference to the disk's driver in Config.sys, and a corresponding line calling Mscdex.exe in your Autoexec.bat file. You can create these if you have the appropriate documentation, but there's an easier way.

Shut down Windows 95, but choose the Restart in MS-DOS Mode option. When you get to the DOS prompt, make backup copies of your Autoexec.bat and Config.sys files, then run the DOS installation procedure for your CD-ROM drive. This will copy the required driver to your hard disk from the CD drive's software disk. Windows 95 includes a copy of Mscdex.exe, which you should find in the Windows\Command folder. The installation process will make the changes to the Autoexec.bat and Config.sys files that you'll need for your start-up disk; all you need to do is copy the two initialization files plus the driver and Mscdex.exe files to the floppy disk and edit the file references in Autoexec.bat and Config.sys, and you'll be

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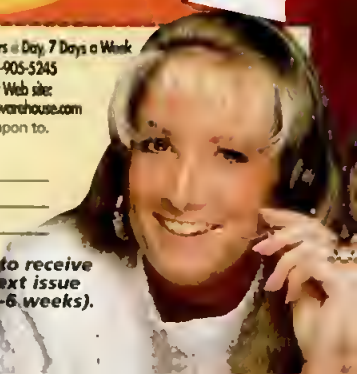
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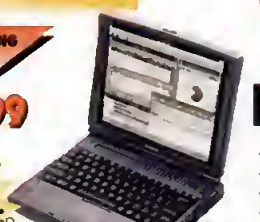
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all set. Remember to restore the original versions of the Autoexec.bat and Config.sys files from your backup copies before you restart your computer.

Now comes the most important step. Reboot the system with the start-up disk in the drive. If your system's CMOS is set to try booting from C: first, you may have to temporarily change the settings so that the system boots first from the A: drive. Once the system is up and running, make sure the CD-ROM drive and any other essential devices are working correctly. The time to fix any mistakes in your start-up disk's configuration is now, while the hard disk is still functioning correctly.

This same technique can be used for any devices, such as removable disk drives or sound cards, that require real-mode drivers in order to work in DOS mode.—*Alfred Poor*

OPERATING ENVIRONMENTS

Deleting OS/2 Networking Files to Save Space



In order to install OS/2's Web Explorer and other Internet applications, I had to install networking when I installed OS/2 4.0. But I access the Internet only through a dial-up connection. I know there are a lot of networking files on my disk that I don't need. Which files can I safely remove, and how much space will I save?

STEPHEN GASPAR
Philadelphia, Pennsylvania

PC MAGAZINE: Since the target audience of OS/2's Web Explorer was enterprise clients, IBM didn't consider the possibility of users accessing the Internet via dial-up. To get TCP/IP with OS/2 4.0, you have to install networking protocol and transport services. (If you try to install TCP/IP support by running the install program in the TCPIP subdirectory of the CD-ROM, that doesn't set up the desktop properly. It's easiest to go ahead and install the network support.) You're correct that people who don't use a network end up with a fair amount of wasted disk space. Fortunately, it's all in the same area, so it's fairly easy to remove.

Open an OS/2 command prompt and switch to the OS/2 boot drive. The first set of files to remove is everything but NULLNDIS.OS2 in the \IBMCOM\MACS directory:

```
CD \IBMCDM\MACS
MD TEMP
MDVE NULLNDIS.DS2 .\TEMP
DEL *
MDVE TEMP\NULLNDIS.OS2 .
RD TEMP
```

You have recovered 3,171,263 bytes already! Next, you can remove the DLL and PROTOCOL directories and recover another 1,501,747.

```
CD \IBMCDM
DEL DLL
RD DLL
OEL PROTOCOL
RD PROTOCOL
```

You can also delete several files in the IBMCOM directory and pick up some more savings.

```
DEL *.EXE
DEL *.HLP
```

Deleting these files frees an additional 458,400 bytes. You've now retrieved over 5MB of wasted space on the hard disk. Next, you can clean up some wasted memory. Some of those LAN device drivers are loaded into memory at boot time, even though you never use them. Open the CONFIG.SYS file with your favorite text editor. Go to the LIBPATH line and remove the reference to \IBMCOM\DLL. In the PATH line, remove the reference to \IBMCOM. And there are several other lines you can either remove completely or inactivate by adding REM at the beginning:

```
DEVICE=I:\IBMCDM\LANMSGDD.DS2
/I:I:\IBMCOM /S
CALL=I:\IBMCDM\PRDTDCDL\NETBIND.EXE
RUN=I:\IBMCDM\LANMSGEX.EXE
DEVICE=I:\MPTN\PRDTDCDL\AFDS2.SYS
DEVICE=I:\MPTN\PRDTDCDL\IFNDIS.SYS
CALL=I:\DS2\CMD.EXE /O /C
H:\MPTN\BIN\MPTSTART.CMD >NUL
DEVICE=I:\IBMCDM\MACS\NULLNDIS.DS2
RUN=I:\TCPIP\BIN\VDOSCTL.EXE
```

You can also remove the files referenced in those lines for a bit more savings. You could remove the *.MSG files in \IBMCOM too—if you're sure you'll never have an error message—but it's safest to stop at this point.
—*Brian Proffit*

WORD PROCESSING

Getting the Indents You Want in Word



In your July 1996 issue, you discussed paragraph numbering in Microsoft Word 7.0, but you didn't cover the problem we're currently having. The format we prefer indents the first line of a paragraph to indicate level but keeps all the other lines flush left. For example:

I. This first-level paragraph should have only the first line indented.

A. This second-level paragraph should have the first line indented further, but later lines not indented.

i. This third-level paragraph should have the first line indented still further, but later lines not indented.

In WordPerfect, we could easily create this structure, move paragraphs, and increase and decrease the level for a paragraph. WordPerfect would renumber the paragraphs and adjust the indents as needed. We have not been able to accomplish this in Word. When we try numbering paragraphs—using either the Format | Bullets and Numbering command or the Format | Heading Numbering command—Word insists on indenting each level farther than the level before. For example:

I. First Level. This first-level paragraph indents only the first line.

A. Second Level. This second-level paragraph indents the entire paragraph.

Does Word have any way to number paragraphs using the kind of indenting we need?

JOHN SMITH
via the Internet

PC MAGAZINE: Although you can get the result you want fairly easily, the approach isn't at all obvious—particularly for those used to WordPerfect. Word's automatic numbering commands are best understood as quick and dirty shortcuts, with defaults that will work for most people most of the time. To format paragraphs differently, you need to define the heading styles to give you both the number format and the indents you want. Then you can assign the appropriate heading style to each paragraph.

Word gives you several ways to define styles. The most straightforward for this particular task is to use the Style dialog box. Start by choosing Format | Style to open the dialog box, then set the list box in the lower-left-hand corner to All Styles. This tells Word to show all the styles in the Styles box, which is just above the list box. Go to the Styles box, highlight Heading 1, and choose the Modify button to open the Modify Style dialog box.

Next, choose Format | Numbering to open the Heading Numbering dialog box. Pick a format, and choose Modify if you want to change it in any way. The Modify Heading Numbering dialog box is reasonably self-explanatory. To define the number format for any given level, scroll through the levels in the Level box to reach the one you want to change. Change the settings for that level and move on to the next.

In addition to setting the number format for each level, make sure you've entered the right setting in the Distance From Indent To Text box, which defines the space between the number and the beginning of the text. Don't worry about the other options in the Number Position box; you'll override them in a later step. But make sure that the Start At text box shows the number with which you want to

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Prolinea 4000, 4500P (quads)	4Meg/8Meg/16Meg/32Meg 64Meg	34/49/119/239/549
Prolinea 5000, 5000P (pairs)	32Meg/64Meg/128Meg/256Meg	Call
Prolinea 4/25S, 4/33, 4/66	2Meg/4Meg/8Meg	29/39/99
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Prolinea 575, 590, 5100, 5120, 5133 (pairs)	4Meg/8Meg/16Meg/32Meg	39/42/99/169
Prolinea 5100, 5120, 5133, 5150, 5166 (EDO pairs)	4Meg/8Meg/16Meg/32Meg	39/42/99/169
Prolinea 575E, 1000, 120E, 575MX (pairs)	4Meg/8Meg/16Meg/32Meg	39/42/99/169
Prolinea 560MX, 5120MX (pairs)	4Meg/8Meg/16Meg/32Meg	39/42/99/169
Prolinea P150E, P166E (pairs)	8Meg/16Meg/32Meg	69/119/239
Prolinea 590 5/75 5/90 5/120, 5/180 (pairs)	4Meg/8Meg/16Meg/32Meg	39/42/99/169
Prosignia 500 5/60 5/120, 5/150 (pairs)	4Meg/8Meg/16Meg/32Meg	39/42/99/169

COMPAQ NOTEBOOK/LAPTOP MEMORY

Armada 1100 T	8Meg/16Meg/32Meg/64Meg	69/129/239
Armada 4100 4110, 4129, 4180 (pairs)	4Meg/8Meg/16Meg/32Meg	69/129/249
Concerto 4/25, 433	4Meg/8Meg/16Meg	49/69/139
Contura 4/25 C CX	4Meg/8Meg/16Meg	49/69/139
Contura 4000, 4000C 410C, 410CX	4Meg/8Meg/16Meg	49/69/139
Contura 420C, 420CX, 430C, 430CX	4Meg/8Meg/16Meg/24Meg	49/69/109/169
Contura Aero 4/25, 4/33	4Meg/8Meg 16Meg	39/79/189
LTE 5000, 5100, 5200, 5300	8Meg/16Meg/32Meg/64Meg 128Meg	79/129/249/479
LTE Elite 440C, CX, 475CX	4Meg/8Meg/16Meg/24Meg	49/69/199/499
LTE Lite 4/25	4Meg 8Meg 16Meg	29/69/189
Presario 1000 1010 1020 1000	8Meg/16Meg/32Meg	89/189/399

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ARCHIVE UPGRADES	OK Bd	256k	1	2	2.5	4	5	6	8	16	32
Brother 330 631 641 645	–	–	30	60	–	–	–	–	–	–	–
Canon LBP 930	–	–	60	–	–	30	–	–	–	–	–
Canon LBP 950 1260	–	–	–	30	–	30	–	–	60	60	120
Canon LBP4 4Lite 4plus	–	–	60S	120	–	–	–	–	–	–	–
Epson 8000, Action Laser	–	–	30	–	–	100	–	–	–	–	–
Epson Action Laser 1200 4000	–	–	30	60	–	60	–	–	60	60	–
Epson Action Laser II	–	–	74	–	172	–	–	272	–	–	–
Epson 8000 1000 2000 4100 4300	–	–	60	–	172	–	–	272	–	–	–
Epson 1000 1080 4000 5300	–	–	–	60	–	120	–	–	–	–	–
HP 2, 2D-	–	–	–	60	–	70	–	–	–	–	–
HP 2, 2D, 2P, 2P Plus	–	–	–	60	–	30	–	–	–	–	–
HP 4, 4M, 4Si, 4SiMX	–	–	–	19	–	49	–	–	70	–	–
HP 4P, 4PLUS, 4MPlus 1000 1000CM	–	–	0	19	–	30	–	–	60	–	–
HP 4L	–	–	60	–	–	–	–	–	–	–	–
HP 5D	–	–	0	–	–	60	–	–	60	–	–
HP 5L	–	–	60	60	–	30	–	–	60	–	–
HP 5P, 5MP 4V, 4MV, 5P, 5MP	–	–	0	30	–	30	–	–	60	60	–
HP Design Jet 600 650 350	–	–	–	30	–	30	–	–	60	300	180
HP Resolution 600, 600 Plus 300 300	–	30	–	60	–	–	–	–	60	–	–
HP Deskjet 1200C, 1200CP	–	–	–	60	–	60	–	–	60	–	–
HP Pamphlet XL300	54	–	–	–	–	60	–	–	144	288	–
IBM Laser 4019, 4019E	–	–	–	–	139	–	–	–	–	–	–
IBM Laser 4029 4037	–	–	–	–	–	60	–	–	–	–	–
IBM Lexmk 4039, 4079	–	–	–	60	–	60	–	–	60	–	–
Konica LP 3110, 3115	–	–	60	110	180	–	–	–	–	–	–
Lexmark Optra E, E+, XL 45X	–	–	Call	Call	Call	–	–	–	–	–	–
Lexmark Optra L LX R RX	–	–	–	–	–	30	–	–	60	60	180
Lexmark Valuewriter 800 800	–	–	60	30	–	60	–	–	–	–	–
Lexmark Winwriter 200, 300, 300	–	–	60	60	–	60	–	–	–	–	–
NEC 60 60	–	–	–	60	–	–	–	–	–	–	–
NEC 60 80	–	–	–	70	–	–	–	–	–	–	–
Oki 800	–	–	–	60	–	–	–	–	–	–	–
Oki 400E, 400EX, 410E, 410EX	–	–	60	60	100	–	–	–	100	–	–
Oki 810E EX, 800E, EX, 810E, EX	–	–	60	60	–	–	–	–	60	180	–
Oki 330, 880	–	–	–	60	–	–	–	–	–	–	–
Oki 2300, 8450	–	–	Call	Call	–	–	–	–	–	–	–
Panasonic 4420/4450	–	–	–	70	–	140	–	–	–	–	–
Panasonic 4410/4430	–	–	–	60	–	120	–	–	–	–	–
Panasonic 4450	–	–	60	–	–	–	–	–	–	–	–
Panasonic 4400/4400	–	–	60	60	–	110	–	–	–	–	–
Panasonic 4400 4410	–	–	60	60	–	120	–	–	–	–	–
Panasonic 8400	–	–	14	28	–	30	–	–	–	–	–
Sharp 9400, 9400, 9700X	–	–	60	60	–	110	–	–	–	–	–
Sharp 9400 E H, 9700 H	–	–	60	60	–	–	–	–	–	–	–
TI Microlaser Pro E, Powerpro, Pro 600	–	–	30	60	–	50	–	–	60	–	–
TI Microwriter	–	–	30	60	–	–	–	–	–	–	–

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Compaq Aero, 486 410 420, 330	309	Sharp 7700, 8405 8405	169
Compaq LTe 4000 Series	109	TI Extensa 590 455, 510 510	139
Epson Action Note 400 600	102	TI Extensa 566 566, 580 570	149
Epson Action Note 800, 880, 880, 300	164	TI Extensa 600, 600	181
IMS Thinpad 355 380	89	Toshiba 600, 610	Call
IBM Thinpad 360 C 60 XD	89	Toshiba 400 440 410, 415, 330 435, 430	169
IBM Thinpad 701	89	Toshiba 100 100 110, 115, 300 300	89
IBM Thinpad 750, 750	159	Toshiba 2100 Series	89
IBM Thinpad 700 CD CE CV CX	159	Toshiba 2460 2450 1200 1600, 1860	109
NEC Versa 2000, 2200 2305	245	Toshiba 4900, 4800 4000 4000	100
NEC Versa E V	119	Toshiba T4300, T8400	139

TOSHIBA LAPTOP MEMORY

MODEL	386T, UPGRADED	PRICE
Tosra 350/PS50	4Meg/16Meg/32Meg/64Meg 128Meg	79/129/249/349
Tosra 700 (SRAM)	4Meg, 16Meg/32Meg	79/129/299
Tosra 710, 720	8Meg/16Meg/32Meg/64Meg 128Meg	89/179/299/499/849
T2000SX/E,2200SX/T1600, 1200 C	6Meg	94.00
T2100 2105 2150 2155 2110 2115	4Meg/8Meg/16Meg/24 Meg	49/69/109/189
T4000 C 14400 T4700 T1900 C T1910, T1950 (3.3 v)	4Meg	39.00
T4000 C 14400 T4700 T1900 C T1910, T1950 (3.3 v)	4Meg/8Meg	59.00
T4000 C 14400 T4700 T1900 C T1910, T1950 (3.3 v)	16Meg/32Meg	139/279
T3400CT, T2000 T3000	4Meg/8Meg/16Meg/24Meg	59/79/149/188
T400, 600 T60, T70, 600, 700	4Meg, 8Meg/32Meg	89/129/239
T600, 600 400 410, 600, 600, 630	4Meg, 16Meg/32Meg	89/139/299
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T600 610 C1 Edo 600	4Meg, 16Meg/32Meg	89/129/299

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MODEL	80's UPGRADED	PRICE
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ACERNote 750, 755, 760, 784, 790	4Meg/8Meg/16Meg	59/79/189
ACERNote Light 356, 360, 366	4Meg/8Meg/16Meg	59/79/139
ACERNote Light 336, 350, 359, 361 (pairs)	4Meg/8Meg/16Meg	59/79/139
ACERNote Battery 970, 972	4Meg/8Meg/16Meg/32Meg	89/129/239
ACERNote Pro 950, 954, 956, 957, 959 (pairs)	4Meg/8Meg/16Meg/32Meg	59/79/99
Ambra N Series	4Meg/8Meg/12Meg/16 Meg	89/109/129/189
Ambra SN Series	4Meg/16 Meg	79/179
Ambra N 20, N 33	8Meg/16Meg/32Meg	69/79/139
AST Ascentia 4 Series	8Meg/16Meg/32Meg/64Meg	79/129/299
AST Ascentia P30, P50	8Meg/16Meg/32Meg/64Meg	89/129/299
AST Ascentia 710, 720, 900	8Meg/16Meg/32Meg/64Meg	89/129/299/479
AS1 Ascentia 900N, 4000 810, 910	8Meg/16Meg	79/118
AST Ascentia 910	4Meg/16Meg	79/119
AST Bravo S Explorer	4Meg/16Meg	79/219
AST Notebook Prem Exec 386SX/20/25N	6Meg	69.00
AST Power Exec 3/25C 486EL 486SL	4Meg/16Meg	69/139
AST Power Exec 4/33C	4Meg/16Meg	69/139
AT&T Globalyst 130 200, 200	4Meg/8Meg/16Meg	49/69/139
Austin D4 D42, D42, D42 S9 Series	4Meg/16Meg	69/139
Austin E Series	4Meg/16Meg	69/149
Austin Edge Dual	16Meg/32Meg	199/299
Austin S Series	4Meg/8Meg/16Meg/32Meg	69/89/219/349
Canon I 1100	4Meg/8Meg/16Meg	Call
Canon Innova Book 180, 179	6Meg/16Meg	59/139
Canon Innova Book 280LS	4Meg/8Meg/16Meg/32Meg	69/89/219/349
Canon Innova Book 350CD 360, 870	8Meg/16Meg/32Meg	89/129/299
Canon Innova Book 450, 350	4Meg/16Meg	89/149
CTX EZ Book 3400 Series	4Meg/8Meg/16Meg	59/89/149
DEC Hillside Ultra Models	4Meg/8Meg/16Meg	59/99/99
DEC Hillside Ultra, Ultra S	4Meg/8Meg/16Meg	59/99/189
DEC Hillside VP 570, 570, 580	4Meg/8Meg/16Meg/32Meg	89/129/299/499
DEC Hillside VP 5100, 5120	8Meg/16Meg/32Meg/64Meg	89/129/299/499
DEC Hillside XP	8Meg/16Meg/32Meg	79/139/299
Dell Latitude LM (pairs)	4Meg/8Meg/16Meg	49/69/169
Dell Latitude 433 C CX	4Meg/16Meg	69/149
Dell Latitude LMP (pairs)	4Meg/8Meg/16Meg	39/59/139
Dell Latitude LX, XP	4Meg/8Meg/16Meg	69/89/139
Dell Latitude XP XPi	4 Meg/8Meg/16Meg	69/89/139
Epson ActionNote 880, 880c, 880c, 800cx	4Meg/8Meg/16Meg	39/79/139
Epson ActionNote 880C, 880	4Meg/16Meg	69/139
Epson ActionNote 486, 880C, 880	4Meg/8Meg/16Meg	39/69/109/169
Epson ActionNote 4LC/25, 4LC/33, 4SLC/20, 80	4Meg/8Meg/16Meg	69/89
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Gateway 2400 Nomad 425 DXL/SXL	4Meg/16Meg	140/569
Gateway 2900 888 Nomadic or Liberty	4Meg/16Meg	49/139
Gateway 2000 Solo Series	4Meg/8Meg/16Meg	69/89/139
Gateway 2100 Solo Series	8Meg/16Meg	119/239
Hitachi C Series	8Meg/16Meg/32Meg	79/149/219
Hitachi E Series	8Meg/16Meg/32Meg	79/139/299
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HP Omnibook 300, 300 309	2Meg/4Meg	69/139
HP Omnibook 530, 600	4Meg/8Meg	49/69/99
HP Omnibook 800	4Meg/8Meg/16Meg	79/119/299
HP Omnibook 5000	4Meg/8Meg/16Meg	49/69/109
HP Omnibook 5000, 4000	4Meg/8Meg/16Meg/32Meg	69/119/218
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Midwest Micro Elite or Soundbook	4Meg/8Meg/16Meg	69/89/149
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Midwest Micro Elite or Soundbook CD	4Meg/8Meg/16Meg	69/89/149
NEC Ultralite Versa, V, MP	4 Meg/8Meg/16Meg/20Meg	34/69/199/299
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NEC Versa 4000, 4050 4080	4Meg/8Meg/16Meg/32Meg	39/79/139/299
NEC Versa 6000	8Meg/16Meg/32Meg	109/199/299
Network Echos P75-P1200 (pairs)	8Meg/16Meg	89/129/219
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Sager Midwest, all models	4Meg/8Meg/16Meg/32Meg	69/89/149/299
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Sharp 4650 4600 3670	8Meg/16Meg/32Meg	109/179/349
Sharp 8150, 8650, 8660 7700, 7200	4Meg/8Meg/16Meg	69/109
Sharp 8700, 8800, 8900	4Meg/8Meg/16Meg	49/69/139
Sharp 3010, 3020, 3040, 4000	4Meg/8Meg/16Meg/32Meg	49/69/139/399
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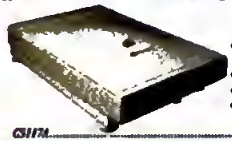
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OkiPage 4W (Windows Only)	$299
OL600e/OL610e/OL810e	$399/$499/$699
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CANON

BJC-240	$179
BJC-4200†	$279
BJC-4550 (wide carriage)†	$499
BJC-620	$399
LBP-465 (Laser)	$369
C2500 (Fax, Scanner, Printer, Copier)	$299

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2390/2391 Plus Dot Matrix Printer	$359/$465
#079 Plus	$239
#039 10 Plus	$169
Optra R	$519
Optra R+/OptraRt+	$1249/$1479
Optra Lx+/Optra Lxn+	$1859/$2229
Optra C	$1869
Optra W/Optra W w/16MB RAM	$2679/$3109

PANASONIC PRINTERS

KX-P6500	$349*
KX-P1150/P2250	$139/$189*
KX-P5126	$13
KX-P2135	$245

NEC

SuperScript 860 (laser)	$479

*Price after manufacturer's mail in rebate. Ask your salesperson for details!

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- IBM PC 300, 350, & 700 Series
- Apple Performa & Power Mac



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DeskPro 4000, P133, 16MB, 1.0GB	$1499
DeskPro 4000 P166, 12MB, 2.5GB, 8X CD-ROM	$2380
DeskPro 6000 P166, 16MB, 1.0GB	$2296
DeskPro 6000 P166, 32MB, 2.1GB, MT	$2929
DeskPro 6000 P-Pro 200, 32MB, 2.1GB, 8X CD-ROM	$3249

FLEX Systems

The Flex 440 Special P-Pro180, 16MB, 1.6GB, MT, 8X, 14"	$1300
Multimedia Tower P-Pro200, 32MB, 4.0GB, 12X, 17", BJC620	$3735
New Year Classic P133, 16MB, 2.1GB, MT, 12X, 15" ZIP Drive	$1807
Multimedia Classic P-Pro180, 16MB, 3GB, MT, 12X, 15"	$2965
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Flatbed Scanner (Artists)	$1335
Flatbed Scanner (Exec)	$811

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Scantouch Flatbed Scanner	$299

MICROTEK

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PageWiz	$114
Scanmaker E6	$553
Scanmaker E6 Pro	$732

HEWLETT-PACKARD

HP ScanJet 4S Scanner	$179
HP ScanJet 5P Scanner (color/grayscale)	$308
HP ScanJet 6C Scanner (color/grayscale)	$229

Notebook Computers

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Satellite 200CDS, P100, 12.1" Act., 810MB	$1535
Satellite Pro 420CDS, P100, 11.3" DS, 1.26GB	$1899
Satellite Pro 430CDT P100, 11.3" Act., 1.26GB	$2068
Satellite Pro 430CDS P120, 11.3" DS, 1.26GB	$2590
Satellite Pro 430CDT P120, 11.3" Act., 1.26GB	$2769
Tecra 500CS P120, 12.1" DS, 1.9GB	$2113
Tecra 500CDT P120, 12.1" Act., 1.9GB	$2748
Tecra 510CDT P111, 12.1" Act., 2.02GB	$4428
Tecra 730CDT P150, 12.1" Act., 2.0GB	$5579
Tecra 730CDT P150 w/MMX, 12.1" Act., 2.0GB	$5579
Tecra 740CDT P166 w/MMX, 14.1" Act., 2.0GB	$6245
Portege 650CT P133, 11.3" Act., 1.35GB	$3849
Portege 660CDT P150, 11.3" Act., 1.35GB	$5099

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P120E, P120, 11.3" Act., 6X CD-ROM, 1.6GB	$2890
P133S, P133, 11.8" Act., 6X CD-ROM, 1.6GB	$3604

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5500CT, P120, 16MB, 1.35GB, 10.4" Act.,	$2948
5500CT, P133, 16MB, 1.35GB, 12.1" Act	$3799
5500CT, P111, 16MB, 2.0GB, 12.1" Act	$4129
800CS, P100, 16MB, 810MB, 10" DS	$2299
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760EL, P133, 12.1" Act., 2.19GB	$4736
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J50, P133, 10.4" Act, 810MB	$2113
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Ae1, P120, 12.1" Act, 1.09GB, 6X CD	$2704

NEC

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Extensa 900CDT P133, 11.3" Act, 1.35GB, 8XCD	$4128
Extensa 600 P120, 12.1" DS, 810MB, 6X CD	$1328
Extensa 650CDT P133, 11.3" Act, 2.1GB, 10X CD	$3629
Extensa 650CD P133, 12.1" DS, 1.35GB, 10X CD	$2881
TM 6020 P120, 11.3" Act., 1.09GB	$3188
TM 6030 P133, 12.1" Act., 1.35GB	$3853

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Armada e130T P134, 11.8" Act, 1.08GB	$4343
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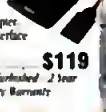
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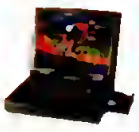


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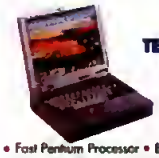


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- Large Clr Display • 6X or 10X CD-ROM

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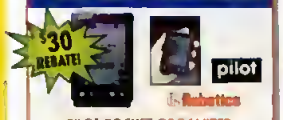


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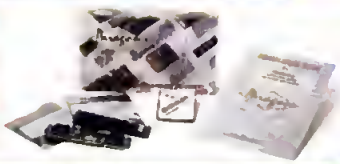
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start numbering (usually 1); make sure the Restart Numbering At Each New Section check box is checked or not, as appropriate. When you're finished, choose OK to return to the Modify Style dialog box.

Next, choose Format | Font to specify the font, style, size, and so on. Then choose Format | Paragraph to define the indents, spacing, and text flow. In particular, on the Indents And Spacing card in the Indentation box, you'll want to make sure that the left and right indents are defined as 0 inches. You'll find that the style is defined as a hanging indent; you'll need to change this to a first-line indent to match the format you need. You'll probably also want to adjust the spacing before and after the paragraph. When you're done, choose OK to close the Paragraph dialog box, then OK again to close the Modify Style dialog box.

Repeat these steps—except for the Format | Numbering step—for as many heading levels as you need. You don't need to repeat the Format | Numbering step at lower levels, because you already defined the number format for all heading levels when you defined Heading 1. When you've finished, choose OK to close the Style dialog box and return to your document.

At this point, you can apply the styles and let Word adjust the numbering and indents automatically. Note that you have several choices for applying a heading style. Probably the easiest is to use Alt-Shift–left arrow or Alt-Shift–right arrow. If there are no paragraphs formatted as headings earlier in your document, Alt-Shift–left arrow will format the paragraph as Heading 1 and Alt-Shift–right arrow will format it as Heading 2. If there are any earlier heading paragraphs, Alt-Shift–left arrow will format the paragraph with the same heading level as the last heading style. Alt-Shift–right arrow will format the paragraph as one level lower.

Once a paragraph is formatted with a heading style, Alt-Shift–left arrow will format it as one level higher. Alt-Shift–right arrow will format it as one level lower. Alt-Shift-5 (the 5 on the numeric keypad) will format it as Normal. If you move a paragraph, it will retain its heading level and automatically change its number as appropriate.—*M. David Stone*

SPREADSHEETS

Serial Date Problems In Quattro Pro and WordPerfect

The serial date numbers Quattro Pro and WordPerfect use are not compatible with each other. If you import a Quattro Pro spreadsheet containing dates into WordPerfect, the dates will vary by one day. This appears to be caused by the products' different start serial dates. Serial date 1 is December 31, 1899, in Quattro Pro, and is January 1, 1900, in WordPerfect.

Try entering the following into two columns in Quattro Pro:

12/25/96	*Christmas Day*
12/26/96	*Boxing Day*
01/01/97	*New Year's Day*

Import the spreadsheet as a table into WordPerfect using Insert | Spreadsheet/Database | Import and format the first column of the table as Date. You will note that Christmas now falls on December 26, Boxing Day on the 27th, and New Year's Day on the 2nd of January!

ANDY CASEY
Nepean, Ontario, Canada

PC MAGAZINE: Strange but true. Corel has taken pains to make Quattro Pro and WordPerfect look like the offspring of the same parents, but they are siblings by acquisition, not birth, and they aren't as compatible as they need to be. Serial date values in Quattro Pro are misinterpreted by WordPerfect whether you import them or link them (using Insert | Spreadsheet/Database | Create Link). But if you simply paste in the dates from the Clipboard, WordPerfect gets them right.

Your dates will also be correct in WordPerfect if they originate as text on the Quattro Pro spreadsheet. For example, suppose Christmas looks like this on the worksheet:

12-25-96

Quattro Pro regards this as a piece of text rather than as a date, and when you import it into WordPerfect, the text looks exactly as it did in Quattro Pro. And now you can assign the critter the date format in WordPerfect, and lo, it turns into December 25, 1996.
—*Craig Stinson*

DATABASES

Documenting Microsoft Access Databases

I have developed some Microsoft Access databases for use at my office that have become large and complex. I spend a lot of time manually trying to keep the documentation of the structure of the tables, queries, forms, reports, macros, and modules current so that I know how all the pieces fit together. I do this by keeping the structure in a Microsoft Word document. Is there an add-on software package for Access that does this automatically, or do you have any suggestions for making this an easier task?

MEL A. ST. JOHN
Thousand Oaks, California

PC MAGAZINE: I'm aware of one built-in tool and one third-party product that can help. Starting with Version 2.0, Access has included a database documenter that you may have overlooked. To see it in Access 2.0, select the File | Add-Ins | Database Documentor. In Access 95 or Access 97, select Tools | Analyze | Documentor. This built-in documentation tool provides an easy way to view, print, output, or save object-design characteristics. For example, with the Access 97 version, you can produce a printout that includes information about the table, such as table properties, column definitions, column properties, table relationships, table indexes, and user and group permissions. You can output this information to an Excel file, a text file, a rich-text-format file or an .HTML file; you can also send it to a table in your database. You can produce similarly voluminous output regarding queries, forms, reports, macros, modules, and/or the current database.

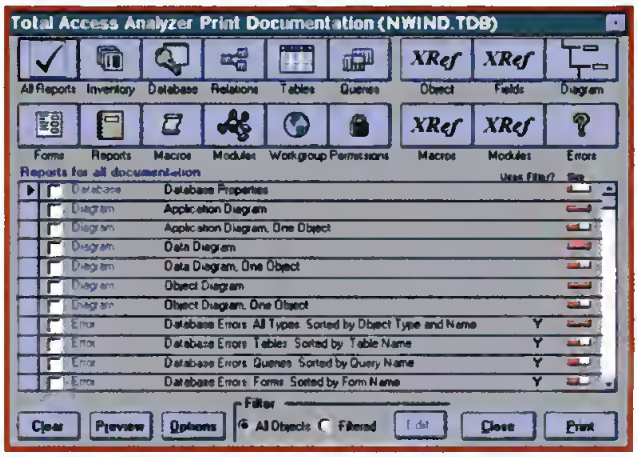


FIGURE 1: *FMS's $199 Total Access Analyzer can produce reams of detailed information about your Microsoft Access databases. Over 130 high-quality reports are available.*

I've seen one third-party package that's very good. Total Access Analyzer, from Vienna, Virginia–based FMS, goes well beyond the built-in tools provided by Microsoft. For example, Total Access not only fully documents objects, it also detects and reports many types of errors. It will detect command buttons that call nonexisting functions, for instance, and recognize places where you've

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5-Year TAP Warranty .. CALL

Model	CPU	Screen	RAM/HD	CD	Price
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430CDS	120MHz	11.3" Dual Scan	16MB/1.2GB	10X	2499
420CDT	100MHz	11.3" Active	8MB/1.2GB	6X	CALL
430CDT	120MHz	11.3" Active	16MB/1.2GB	10X	3399

Satellite Pro 430



NEW MMX Models Available

Tecra 510

Call about 200, 660, 730 & 740 models

Tecra 500 & 510

- 120 & 133MHz processors
- Up to 10X CD-ROM drives on selected models
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Tecra 500CS ~~$2199~~
3-Year TAP Warranty ... $99.97
5-Year TAP Warranty ... $349.97

Call for Lower Prices

Model	CPU	Screen	RAM/HD	CD	Price
500CS	120MHz	12.1" Dual Scan	16MB/1.3GB	Opt.	~~$2199~~
500CDT	120MHz	12.1" Active	16MB/1.3GB	6X	~~3399~~
510CDT	133MHz	12.1" Active	16MB/2.1GB	10X	~~4599~~

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520T	120MHz	11.3" Active	8/810MB	6X	2799
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555T	150MHz	11.3" Active	16MB/1.3GB	6X	4399 *

* Includes built-in 28.8 fax modem

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LifeBook™ 500 Notebook

LifeBook™ 600 Notebook

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- 12.1" Active Matrix displays
- Integrated 28.8 fax modem

Lifebook™ 635T **$3999**
3-Year TAP Warranty..... $99.97
5-Year TAP Warranty... $499.97

Model	CPU	Screen	RAM/HD	CD	Price
635T	133MHz	12.1" Active	16MB/1.3GB	Opt.	$3999
635T	133MHz	12.1" Active	16MB/1.3GB	Opt.	3999 *

* Includes Windows for Workgroups or Windows 95



LifeBook™ 600 Notebook

Additional models are available with Windows for Workgroups or Windows 95

IBM®

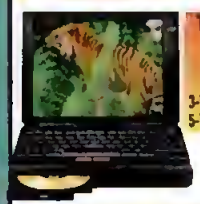
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PC MAGAZINE EDITORS' CHOICE

ThinkPad® 760EL **$3399**
3-Year TAP Warranty..... $99.97
5-Year TAP Warranty... $459.97



ThinkPad® 760

Model	CPU	Screen	RAM/HD	CD	Price
760EL	100MHz	11.3" Dual Scan	8/810MB	Opt.	$3399
760EO	133MHz	12.1" Active	16MB/1.2GB	4X	$399
760E	150MHz	12.1" Active	16MB/2.1GB	Opt.	$699
760ED	133MHz	12.1" Active	16MB/2.1GB	6X	5999

Additional models available Call for details.



ThinkPad® 365XD

ThinkPad® 365X **$2299**
3-Year TAP Warranty... $229.97
5-Year TAP Warranty... $349.97

ThinkPad® 365X & XD

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- 10.4" & 11.3" SVGA displays
- 16-bit sound, speakers and microphone
- Infrared port for wireless communications
- External floppy drive on 365XD

Call about 4.1 lb. ThinkPad 560 models

Model	CPU	Screen	RAM/HD	CD	Price
365X	133MHz	11.3" Dual Scan	8MB/1.1GB	Opt.	$2299
365XD	120MHz	10.4" Active	8MB/1.1GB	6X	2499
365XD	133MHz	11.3" Active	8MB/1.4GB	6X	3499

New models available.
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digital™

MMX Models Now Available

HiNoteVP & VP 500

HiNote VP **$1499**
3-Year TAP Warranty... $149.97
5-Year TAP Warranty... $229.97

SPECIAL PRICE

Model	CPU	Screen	RAM/HD	CD	Price
HiNote VP	120MHz	11.3" Dual Scan	8MB/1.08GB	Opt	$1499
VP 520	120MHz	11.3" Dual Scan	8MB/1.08GB	6X	2449
VP 525	120MHz	11.3" Active	8MB/1.08GB	6X	2949
VP 535	133MHz	12.1" Active	8MB/1.44GB	6X	3599
VP 545	150MHz MMX	12.1" Active	8MB/1.44GB	6X	3899

Product differs slightly from photo



Digital HiNote VP 500

HiNote Ultra II

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- 11.3" Super VGA, Active Matrix displays
- 16MB of RAM memory

HiNote Ultra II **$4499**
3-Year TAP Warranty..... $99.97
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Win NT 4.0 Models Available

Model	CPU	Screen	RAM/HD	CD	Price
Ultra II	133MHz	11.3" Active	16MB/1.35GB	Opt.	$4499
Ultra II	150MHz	11.3" Active	16MB/1.44G	Opt.	4799*
Ultra II	133MHz	11.3" Active	16MB/1.35GB	Opt.	4699**
Ultra II	150MHz	11.3" Active	16MB/1.44G	Opt.	4799

* Features Win for Workgroups, ** Features Win NT

Super Light at 4.0 lbs.



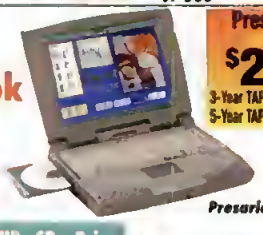
Ultra II with external Floppy Dock

COMPAQ

Presario Notebook

- 133MHz Pentium processor
- 10X CD-ROM drive
- 128-bit PCI graphics
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- MS Works, Quicken and more!

Presario 1070 **$2899**
3-Year TAP Warranty... $259.97
5-Year TAP Warranty... $399.97



Presario

Model	CPU	Screen	RAM/HD	CD	Price
1070	133MHz	12.1" Dual Scan	16MB/1.1GB	10X	$2899

LTE 5000

Model	CPU	Screen	RAM/HD	CD	Price
5250	120MHz	10.4" Active	16/810MB	Opt	$3099
5280	120MHz	11.3" Active	16MB/1.35GB	Opt	3859
5300	133MHz	12.1" Active	16MB/1.35GB	Opt	4349
5380	133MHz	12.1" Active	16MB/2.2GB	Opt.	5439
5400	150MHz	12.1" Active	32MB/2.2GB	Opt	5539

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LTE 5250 **$3099**
3-Year TAP Warranty..... $99.97
5-Year TAP Warranty... $459.97



LTE 5000

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- 166MHz Pentium processor with MMX™ technology
- 13.3" Active Matrix display
- 10X CD-ROM drive
- 64-bit PCI bus architecture

Model	CPU	Screen	RAM/HD	CD	Price
6200MX	166MHz MMX	13.3" Active	32MB/2.1GB	10X	$6399



NEC Versa 6200

13.3" DISPLAY

Versa 6200MX $6399
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NEC Versa 6050

- 150MHz Pentium processors with MMX technology
- 10X CD-ROM drives
- 12.1" displays
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Model	CPU	Screen	RAM/HD	CD	Price
6050H	150MHz MMX	12.1" Active	16MB/1.4GB	10X	$4699
6050MX	150MHz MMX	12.1" Active	16MB/2.1GB	10X	5199



NEC Verse 6050

Versa 6050H $4699
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9020

Model	CPU	Screen	RAM/HD	CD	Price
9020	120MHz	12.1" Dual Scan	16MB/1.1GB	6X	$1999

WideNote

Model	CPU	Screen	RAM/HD	CD	Price
W1000	133MHz	11.2" Wide Dual Scan	16MB/1.1GB	Opt.	$2799
W100T	133MHz	11.2" SHA Wide Active	16M8/1.1GB	Opt.	3299


Sharp 9020

Ask About Sharp's Super-Light Zaurus PDAs

$1999
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5-Year TAP Warranty... $299.97

CALL ABOUT NEW 150MHz 9200 MODELS

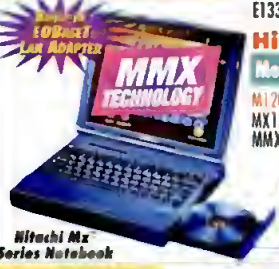
HITACHI MOBILIZED COMPUTING

Hitachi E™

Model	CPU	Screen	RAM/HD	CD	Price
E1000	100MHz	11.3" Dual Scan	8/810MB	Opt.	$1499
E1330N	133MHz	11.3" Dual Scan	16/1.08GB	Opt	1799
E133T	133MHz	11.3" Active	16/810MB	Opt.	2199

Hitachi Mx™

Model	CPU	Screen	RAM/HD	CD	Price
M1200	120MHz	11.3" Dual Scan	16MB/1.0GB	8X	$2199
MX133T	133MHz	12.1" Active	16MB/1.35GB	8X	4299
MMX166T	166MHz MMX	12.1" Active	16MB/2.1GB	8X	5199



Hitachi Mx™ Series Notebook

Additional M™ series models available. Call for details.

M1200 $2199

olivetti personal computers

Echos & Echos Pro

Model	CPU	Screen	RAM/HD	CD	Price
Echos	100MHz	11.3" Dual Scan	8MB/1.3GB	6X	$1699
Echos	100MHz	10.4" Active	8MB/1.3GB	6X	1999
Pro	133MHz	12.1" Dual Scan	16MB/1.3GB	8X	2999
Pro	133MHz	12.1" Active	16MB/2GB	8X	3499
Pro	150MHz	12.1" Active	16MB/2GB	8X	3999


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Echos $1699
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5-Year TAP Warranty... $299.97

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Ascentia A & P

Model	CPU	Screen	RAM/HD	CD	Price
A41	120MHz	11.3" Dual Scan	16MB/1.0GB	6X	$2199
A42	120MHz	12.1" Active	16MB/1.0GB	6X	2799
P50	133MHz	12.1" Active	24MB/1.0GB	6X	3699*
P50	133MHz	12.1" Active	24MB/2.1GB	6X	4299*

* Features 28.8 fax modem

Ascentia J

Model	CPU	Screen	RAM/HD	CD	Price
J55	133MHz	11.3" Active	16MB/1.0GB	Opt.	$2399


Ascentia A

Ascentia A41 $2199
3-Year TAP Warranty... $229.97
5-Year TAP Warranty... $349.97

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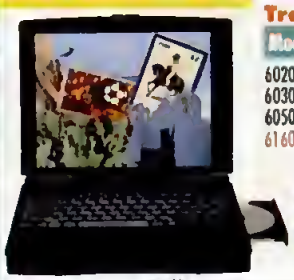
TEXAS INSTRUMENTS

Extensa 600

Model	CPU	Screen	RAM/HD	CD	Price
600CD	120MHz	12.1" Dual Scan	8/810MB	6X	$1819

TravelMate 6000

Model	CPU	Screen	RAM/HD	CD	Price
6020	120MHz	11.3" Active	8MB/1.08GB	6X	$2699
6030	133MHz	12.1" Active	16MB/1.35GB	6X	3399
6050	150MHz	12.1" Active	16MB/1.35GB	6X	3699
6160	166MHz MMX	12.1" Active	32MB/2.1GB	10X	4899


Extensa 600CD

Speedy Pricing Price on 600CD Available while supplies last

Extensa 600CD $1819
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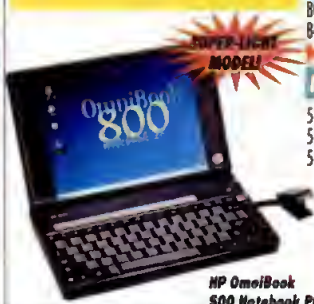
HP OmniBook 800

Model	CPU	Screen	RAM/HD	CD	Price
800CS	100MHz	10.0" Dual Scan	16/810MB	Opt	$2449
800CT	133MHz	10.4" Active	16MB/1.4GB	Opt.	3469

HP OmniBook 5500

Model	CPU	Screen	RAM/HD	CD	Price
5500CTS	120MHz	10.4" Active	16MB/1.35GB	Opt	$2739
5500CTS	133MHz	12.1" Active	16MB/1.35GB	Opt.	3279
5500CTS	133MHz	12.1" Active	16MB/2GB	Opt.	3549

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HP OmniBook 800 Notebook PC

HP OmniBook 800CS $2449
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Double the Cache
More efficient throughput

Faster Processors
Enhance your PC's speed

Exciting New Software
All designed for MMX technology

Call about MMX™ Technology Computers from the Following Manufacturers



Notebooks

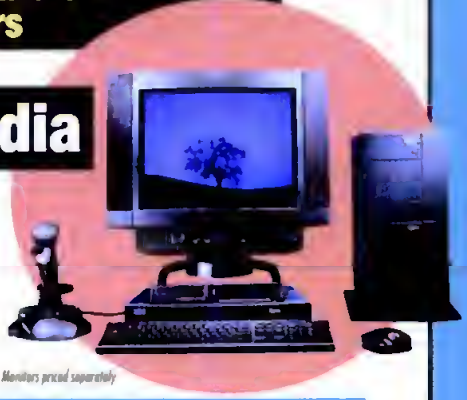
intel inside pentium

Model	CPU	Screen	RAM/HD	CD	Price
Toshiba					
730XCDT	P150MHz MMX	12.1" Active	16MB/2.0GB	10X	$5799
740CDT	P166MHz MMX	13.3" Active	16MB/2.0GB	10X	6799
Digital					
VP545	150MHz MMX	12.1" Active	8MB/1.44GB	6X	$3899
NEC					
2655CD	150MMX	12.1" Dual Scan	16MB/1.4GB	10X	CALL
2655CDT	150MMX	12.1" Active	16MB/1.4GB	10X	CALL
6200MX	166MHz MMX	13.3" Active	32MB/2.1GB	10X	$6399
6050H	150MHz MMX	12.1" Active	16MB/1.4GB	10X	4699
6050MX	150MHz MMX	12.1" Active	16MB/2.1GB	10X	5199
Hitachi					
MMX166T	166MHz MMX	12.1" Active	16MB/2.1GB	8X	$5199
Texas Instruments					
6160	166MHz MMX	12.1" Active	32MB/2.1GB	10X	$4899

TOSHIBA
digital
NEC
HITACHI
TEXAS INSTRUMENTS

Multimedia

intel inside pentium



Monitors priced separately

Model	CPU	RAM/HD	CD	Price
Hewlett Packard				
7320	166MHz MMX	16MB/2.1GB	16X	$1799
7360	200MHz MMX	32MB/3.8GB	16X	2399
IBM				
S80	166MHz MMX	32MB/3.2 GB	8X	$2399*
S90	200MHz MMX	32MB/3.2 GB	8X	2599*
Campaq				
4764	166MHz MMX	24MB/2.5GB	16X	$1899
4770	200MHz MMX	32MB/3.8GB	16X	2299
AST				
9402	166MHz MMX	32MB/2.0GB	16X	$1899
9406	200MHz MMX	64MB/4.0GB	16X	2799
SONY				
VAIO	166MHz MMX	32MB/2.5GB	16X	$1999
VAIO	200MHz MMX	32MB/3.8GB	16X	2399

* Cordless mouse and joystick included

HEWLETT PACKARD
IBM
COMPAQ
AST
SONY



Monitors priced separately

Desktops

intel inside pentium

Model	CPU	RAM/HD	CD	Price
IBM				
PC330	P166MHz MMX	16MB/2.5GB	Opt.	$2051
PC350	P166MHz MMX	16MB/2.5GB	Opt.	2085
PC350	P166MHz MMX	32MB/2.5GB	Opt.	2418
PC350	P200MHz MMX	32MB/2.5GB	Opt.	2571
Digital				
Celebris FX	P200MHz MMX	32MB/2.1GB	8X	$2549

IBM
digital

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- MPEG Level 1 playback support
- 33.6 data/fax/voice modem
- 3-D graphics and sound
- Loads of FREE software

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Model	CPU	RAM/HD	CD	Price
9402	166MHz MMX	32MB/2.0GB	16X	$1899
9406	200MHz MMX	64MB/4.0GB	16X	2799

Monitors priced separately

Advantage 9402
$1899
3-Year TAP Warranty... $199.97
5-Year TAP Warranty... $299.97



Monitors priced separately

AST Advantage Multimedia Product differs slightly from photo

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Aptiva S Multimedia

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- Integrated audio on optional monitor
- Vivid graphics with Total Image 3D™
- 3D stereo sound with Theater Sound™

Model	CPU	RAM/HD	CD	Price
S64	166MHz	16MB/2.5GB	8X	$1799
S76	200MHz	32MB/2.5GB	8X	1999
S66	166MHz	16MB/3.2GB	8X	2169*
S80	166MHz MMX	32MB/3.2 GB	8X	2399*
S90	200MHz MMX	32MB/3.2 GB	8X	2599*

* Cordless mouse and joystick included

Aptiva S Monitors

Model	Size	View	Resolution	Price
MM50	15"	13.7"	1024 x 768	$499
MM70	17"	15.7"	1024 x 768	799

Aptiva C Models also available



Monitors priced separately

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Unique MediaConsole™ puts your CD-ROM, floppy and controls at your fingertips

Aptiva S64
$1799
3-Year TAP Warranty... $99.97
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We are Compaq Authorized



Monitors priced separately Compaq Presario Multimedia

Presario Multimedia

NEW

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- 3D surround sound with JBL Pro speakers
- Tons of FREE educational and business software
- 33.6 data/fax/modem
- Up to 3.8 GB hard drives

Model	CPU	RAM/HD	CD	Price
4764	166MHz MMX	24MB/2.5GB	16X	$1899
4770	200MHz MMX	32MB/3.8GB	16X	2299

Presario Monitors

Model	Size	View	Resolution	Price
Presario	14"	12.9"	1024 x 768	$399
Presario	15"	13.5"	1024 x 768	479
Presario	17"	15.6"	1280 x 1024	749

16X CD-ROM

Presario 4764
$1899
3-Year TAP Warranty... $199.97
5-Year TAP Warranty... $299.97

HEWLETT® PACKARD

16X CD-ROM



Monitors priced separately

HP Pavilion Multimedia Product differs slightly from photo

Pavilion 7320
$1799
3-Year TAP Warranty... $199.97
5-Year TAP Warranty... $299.97

UP TO 200 MHz PENTIUM WITH MMX TECHNOLOGY

Pavilion Multimedia

- 16X CD-ROM drives
- Up to 200MHz MMX Pentium processors
- Tons of FREE CD-ROM titles
- 33.6 data/fax modem with speaker phone
- 16MB or 32MB EDO RAM memory
- 3D stereo audio and graphics

Model	CPU	RAM/HD	CD	Price
7320	166MHz MMX	16MB/2.1GB	16X	$1799
7360	200MHz MMX	32MB/3.8GB	16X	2399

Monitors priced separately

TOSHIBA

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assigned the same hotkey to more than one control. Total Access also lists unused tables, queries, and macros.

The product produces over 130 high-quality customizable reports (see Figure 1 for a glimpse of some of the options). For example, you can create a comprehensive application report that details how your application works by showing all procedure calls, macro references, and form and report events in bracketed, hierarchical fashion. You can print a relationships report that shows individual table relationships with property definitions, or a relationships-window report that looks like Access's own relationships window. A variety of dictionary and cross-reference reports are available too.

The program works by analyzing your database, collecting the results into another database, then producing reports on the results. You don't have to print the reports; you can view the results directly without producing hard-copy output. The reports are ordinary Access reports—you can even modify their design—but they're good enough that you'll probably have little need to change them.

If you do a lot of custom programming, you'll appreciate Total Access's module reports. You can specify the font and color of comments and code, and you can generate procedure indexes and cross-reference reports. You can also choose "bracketed" module printouts, with block constructs clearly indicated and code properly indented.

Total Access Analyzer is comprehensive and flexible, and it can produce a lot of detailed documentation. At $199, it's not for casual users, but if you regularly develop Access databases it's well worth the investment. As of this writing, only Access 2.0 is supported. Contact FMS at 888-220-6234 or *www.fmsinc.com* for more information.
—Sal Ricciardi

GRAPHICS

Cross-Platform Compression

I have a small but busy art studio and consider myself knowledgeable about computer graphics. I work with Adobe Photoshop 3.0.5 for Windows. I've found it best to work with CMYK EPS (Encapsulated PostScript) files. The format gives me control over the RGB-to-CMYK conversion process and lets me do some pretty interesting stuff with clipping paths and custom halftone shapes.

My troubles are with file sizes. A full-bleed spread or poster-size image at high resolution (266 or 300 dpi) can be hundreds of megabytes when saved as an .EPS file. Sharing these files with my Mac-based clients and service bureau is a nightmare. In many instances, the file sizes exceed the capacity of my SyQuest cartridges, and they take forever to transmit by modem. Is there any way to make moving these files from a PC to a Mac (and back again) any easier?

JACK FETZER
Rochester, New York

PC MAGAZINE: I can suggest a number of different solutions to your problem. The straightforward approach would be to upgrade from high-capacity removable media (such as your SyQuest drive) to *really* high-capacity removable media, such as the 1GB Iomega Jaz drive. Unfortunately, this solution would require your clients and service-bureau contacts to invest in new hardware as well—something that may not be feasible.

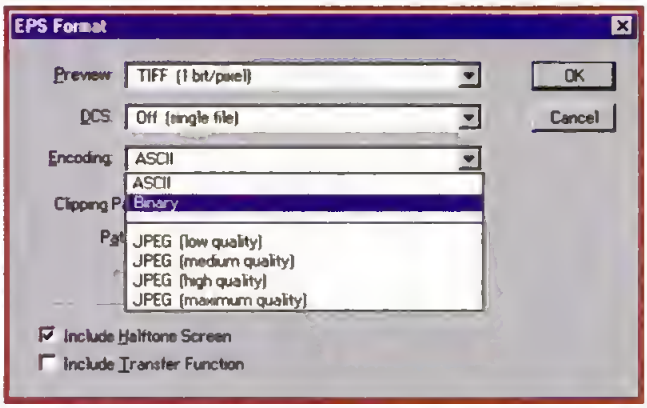


FIGURE 2: *Adobe Photoshop gives you three encoding options when saving an .EPS file.*

Looking at Photoshop's built-in capabilities, I'd suggest you choose the binary-encoding option instead of ASCII for your .EPS files (Figure 2). Found in the Save As .EPS dialog box, binary encoding will typically produce a file half the size as an ASCII-encoded .EPS file. Binary .EPS files store data as a sequence of 8-bit codes rather than as a readable list of PostScript commands, as ASCII is. As long as your service bureau and your clients are using up-to-date software and relatively new printers, binary .EPS files should not represent any kind of a problem.

Compatibility problems may sometimes occur, however, when opening or (especially) printing binary .EPS files. If that happens, you're stuck with the much larger ASCII .EPS files. To reduce file sizes for storage and transmission, try a third-party compression utility. As I'm sure you've discovered, no one compression program runs on both Mac and PCs. But I've discovered a hassle-free workaround.

On your PC, compress the file using the industry-standard PKZIP utility (or any other utility that produces a .ZIP file). Though the exact compression ratio will vary depending upon the content of the file, photographic images will average a compression ratio of 2 to 1. Your Mac-based contacts can decompress the file using Aladdin Systems' StuffIt Deluxe. When returning the file to you, Mac users can compress it with StuffIt to produce a .SIT file. PKZIP won't unstuff a .SIT file, but you can download a free utility called StuffIt Expander for Windows from Aladdin's Web site, at *www.aladdinsys.com*. I tried this system, and it worked perfectly. StuffIt produced slightly smaller files, and PKZIP was marginally faster. The important point is that I was able to transfer large bitmaps between a PC and a Mac easily, without any loss in quality.

One word of warning: Don't choose the JPEG compression option when generating your .EPS files. Although JPEG will produce the smallest .EPS files (only one-tenth the size of a comparable ASCII file), it does so using a lossy compression method. Each time you open (decompress) and save (recompress) a JPEG file, Photoshop discards what it judges to be redundant data. The cumulative effect of repeated Open/Save operations can be a noticeably degraded image. Furthermore, because JPEG compression discards color data (and preserves luminance data), most of the degradation would occur in the one area most important to you—color fidelity.—*Luisa Simone*

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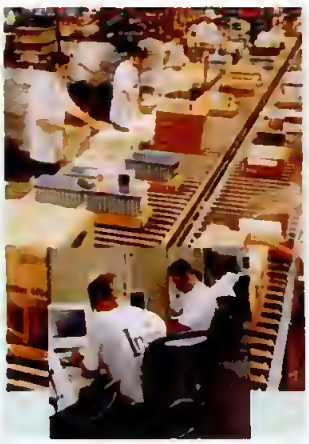
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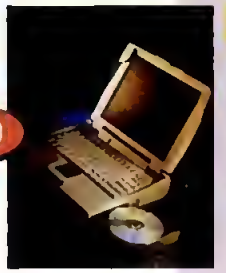
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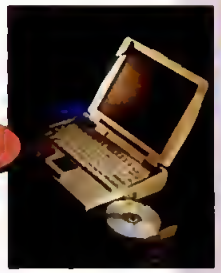
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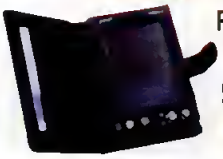
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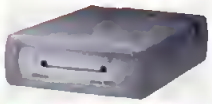
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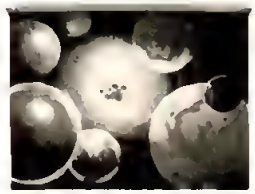
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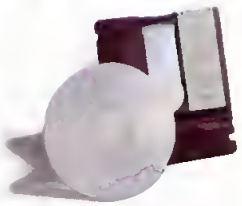
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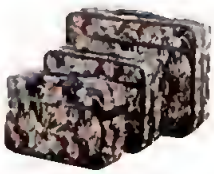
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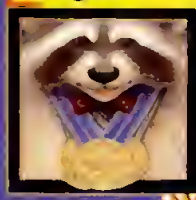
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36746	E-P133 DC	Pent./133	Dual/11.3"	1.0GB	16/40MB		1899
36748	E-P133 T	Pent./133	TFT/11.3"	1.0GB	16/40MB	28.8	2399
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28716	9546-U3A	Pentium/133	1.2GB	16/40MB	12.1" TFT SVGA	4X int.	5198
32963	9546-U9A	Pentium/133	2.1GB	16/80MB	12.1" TFT SVGA	6X int.	5898
32966	9546-U9B	Pentium/150	2.1GB	16/80MB	12.1" TFT SVGA	opt.	5398

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PCC Item#	Speed	RAM	CD-ROM	Price
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34175	Pentium/120MHz	8MB/40MB	6X	1898

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SAMSUNG

Item#	Processor	HD	RAM	CD-ROM	Price
34103	Pentium 100	1.08GB	8/72MB	Opt.	$1699
34104	Pentium 120	1.44GB	16/80MB	Opt.	2099
33356	Pentium 133	1.44GB	16/80MB	6X	2999
33358	Pentium 150	2.1GB	16/80MB	6X	3799

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2X4 JVC (JVC2010)	$385
2X6 Sony (CDU926S)	$395
4X4 Teac, tray loading (CDR50S)	$699
4X4 Yamaha (YCDR100)	$719

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3 - CHOOSE YOUR SOFTWARE

Incat Easy-CD -Supports Windows 3.1, 95, NT (INCATPC)	$50
Astarte Toast CD-ROM Pro -Supports Macintosh (TOAST)	$85
Elektroson Gear Multimedia for PC -Also supports Macintosh (GEAR)	$69
Creative Digital Research CDR HYCD for PC -Supports Windows 3.1, 95, NT -Creates hybrid CDs for PC/Mac/Unix (CDRHYWIN)	$359

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32Bit	PCI	Bus Master	Advansys	(ABP940)	$125
32Bit	PCI	PIO	Adaptec	(A2920KIT)	$159
32Bit	PCI	Bus Master	Adaptec	(A2930KIT)	$189

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WIDE SCSI	$129	$64	$75

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23DMB	Fujitsu IDE	$339
230MB	Smart Storage Solutions SCSI	$339
640MB	Smart Storage Solutions SCSI	$539
640MB	Fujitsu (230MB backwards compatible)	$555
2.6Gig	Smart Storage Solutions	$1649
2.6Gig	Maxoptix	$1599
2.6Gig	Hewlett Packard	$1599
52Gig	Sony 20 slot Juke box w/ 2.6 Gig drive	$4599

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540MB MCD Call about manufacturer's rebate
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1 GB Jaz
Internal SCSI with 1 disk/Ext SCSI with 1 disk $379/$469

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Smart Storage Solutions	2X Write 6X Read	$429
Hewlett Packard	2X Write 6X Read	$549
Smart Storage Solutions	4X Write 4X Read	$799

• CD ROM DRIVES •

Brand	Spin	Model	Speed	Int	Ext
SCSI					
NEC	4X	CDR222	200ms	$99	$189
Philips	8X	PC80S	195ms	$2D5	$305
NEC	8X	CDR141D	145ms	$205	$295
Plextor	8X	PX83CS	115ms	$299	$389
Plextor	12X	PX12TS	1D5ms	$319	$409
Toshiba	12X	XM5701B	115ms	$199	$289
Plextor	12X	PX12CS	1D5ms	$349	$439
Toshiba	15X	XM3801B	99ms	$259	$349
ATAPI IDE				Int	Int kit
NEC	8X	CDR1400	140ms	$110	$140
Mitsumi	8X	CRMCFX800	150ms	$110	$140
Acer	10X	AC910A	150ms	$125	$155
Lite On	12X	LTN126A	155ms	$129	$159
Acer	12X	AC612A	125ms	$135	$165
Toshiba	12X	XM57028	115ms	$159	$189
Teac	12X	CD512A	160ms	$145	$175
Cyber	12X	CYBER12X	150ms	$115	$145
Mitsumi	12X	CRMCFX12X	15Dms	$139	$169
NEC	12/16X	CDR1600	100ms	$175	$2D5
Parallel Port case for IDE CD ROM					$99
PCMCIA case for IDE CD ROM					$189
IDE CD ROM CHANGER					
NEC	4X	CDR4X4	4 Disk	250ms	$99
Panasonic	10X	5QTC510N	5 Oisk	130ms	$249
SCSI CD ROM CHANGERS					
Nakamichi	8X	MJ4B5	4 Disk	150ms	$299

• TAPE DRIVES •

QIC MINICARTRIDGE
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800M8	Seagate	TST800R	$129
3.2Gig	Seagate	TST3200RFT	$199

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4-8GB	Seagate	TST8000(A)	$349

SCSI 4mm DAT

2GB	Hewlett Packard	C1534AI	$609
2-4GB	Seagate	C4324RP	$679
2-4GB	Hewlett Packard	C1536AI	$699
4-8GB	Sony	SDT5000AI	$809
4-8GB	Seagate	C4326NP (DDS2)	$859
4-8GB	**Sony 90MB/min**	**SDT7000AI**	**$909**
12-24GB	Sony ODS3	SDT9000AI	$1399
12-24GB	HP ODS3	C1554AI	$1599
24-48GB	HP	External 6 tape loader C1553AX	$2299
32-64GB	Sony	TSL7000 8 tape autoloader	$2199
48-96GB	Seagate	C4586NP 12 tape autoloader	$2399

SCSI 8mm DAT

3.5-7GB	ExaByte	EXB8205XL	$1269
7-14GB	ExaByte	EXB8505XL	$1889
7-14GB	ExaByte	EXB8700LT	$1029
20-40GB	ExaByte	EXB8900	$4799
70-140GB	ExaByte	EXB10H 10 tape autoloader	$5439

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NovaStor's NovaBack CD contains software for DOS, Win 3.1, Win 95, OS/2, Warp, and Macintosh $79
NovaStor's NovaDisk CD contains software to backup to disk drives and removables $79
Seagate Arcada for Windows NT (call for netware version) workstation/single server/enterprise $239/499/869
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• IDE HARD DRIVES •

IDE	Speed	RPM	Brand	Model	Wty	Price
631M8	14ms	3600	Seagate	ST3630A	3	$145
1200M8	10ms	5400	Fujitsu	M1636T	3	$189
1200MB	14ms	4103	JTS	JTS1200	3	$179
1275MB	12ms	4500	Seagate	ST31276A	3	$195
1280MB	11ms	4500	Quantum	TM31280A	3	$195
1281MB	11ms	5200	Western Digital	WDAC21200	3	$199
1624MB	10ms	5200	Western Digital	WDAC21600	3	$219
1670MB	11ms	4480	Maxtor	MB1750A	3	$215
1700MB	10ms	5400	Fujitsu	M1623T	3	$209
1700MB	12ms	4500	Seagate	ST31720A	3	$215
2000MB	14ms	4103	JTS	JTS2000	3	$219
2004MB	11ms	4480	Maxtor	M72004A	3	$255
2100MB	11ms	5200	Western Digital	WDAC22100	3	$239
2100MB	9ms	5400	Fujitsu	M1624T	3	$235
2132MB	12.5ms	4500	Seagate	ST32132A	3	$247
2168MB	10.5ms	4500	Quantum	TM32160A	3	$249
2500MB	**9ms**	**5400**	**Fujitsu**	**M1638T**	**3**	**$249**
2550MB	15ms	3600	Quantum	BF2500A	3	$229
2550MB	10.5ms	4500	Quantum	TM32550A	3	$262
2559MB	11ms	5200	Western Digital	WDAC32500	3	$275
2560MB	11ms	5400	Seagate	ST52520A	3	$275
2700MB	12ms	4480	Maxtor	M72700A	3	$269
3166MB	12ms	5200	Western Digital	WDAC33100	3	$299
3254MB	10.5ms	4500	Quantum	TM33200A	3	$292
3500MB	12ms	4480	Maxtor	M83500A	3	$365
3840MB	10.5ms	4500	Quantum	TM33840A	3	$333
4000MB	12ms	5200	Western Digital	WDAC34000	3	$389

• SCSI HARD DRIVES •

SCSI	Speed	RPM	Brand	Model	Wty	Int	Ext
1050MB	9ms	5400	Seagate	ST31055N	3	$339	$409
1280MB	12ms	4500	Quantum	TM31280S	3	$279	$349
2110MB	10.5ms	4500	Quantum	TM32110S	3	$329	$399
2147MB	9ms	5400	Micropolis	MC4421	5	$369	$439
2150MB	9ms	5400	Seagate	ST32155N	5	$475	$545
2150MB	8ms	7200	Seagate	ST32171N	5	$699	$769
3254MB	10.5ms	4500	Quantum	TM33200S	3	$379	$449
4350MB	8ms	7200	Seagate	ST34371N	5	$1089	$1159
4400MB	8ms	7200	Fujitsu	M29545	5	$819	$889
4550MB	8ms	7200	Quantum	XP34550S	5	$939	$1009
4550MB	7.9ms	7200	Micropolis	MC4345	5	$959	$1029
4550MB	**7.5ms**	**10,000**	**Seagate**	**ST34501N**	**5**	**$1669**	**$1739**
4550MB	7.9ms	7200	Micropolis	MC4345AV	5	$1129	$1199
9091MB	8.5ms	7200	Micropolis	MC3391	5	$1689	$1789
9091MB	8.5ms	7200	Micropolis	MC3391AV	5	$1999	$1999
9100MB	9ms	7200	Seagate	ST19171N	5	$2099	$2199
9100MB	8ms	7200	Quantum	XP39100S	5	$1539	$1639
9100MB	10ms	7200	Fujitsu	M2949S	5	$1549	$1649
9100MB	**8ms**	**10,000**	**Seagate**	**ST19191N**	**5**	**$3569**	**$3669**
23.3GB	**13ms**	**5400**	**Seagate**	**ST4234501N**	**5**	**$4029**	**$4129**
WIDE SCSI							
1050MB	9ms	5400	Seagate	ST31055W	5	$389	$529
2150MB	9ms	5400	Seagate	ST32155W	5	$519	$659
2150MB	8ms	7200	Seagate	ST32171W	5	$779	$919
4294MB	8ms	7200	Micropolis	MC3243W	5	$899	$1039
4294MB	8ms	7200	Micropolis	MC3243WAV	5	$999	$1139
4350MB	8ms	7200	Seagate	ST34371W	5	$1189	$1329
4400MB	8ms	7200	Fujitsu	M2954W	5	$869	$1009
4550MB	7.9ms	7200	Micropolis	MC4345W	5	$999	$1139
4550MB	7.9ms	7200	Micropolis	MC4345WAV	5	$1159	$1299
4550MB	**7.5ms**	**10,000**	**Seagate**	**ST34501W**	**5**	**$1699**	**$1839**
4550MB	8ms	7200	Quantum	XP34550W	5	$979	$1119
9091MB	8.5ms	7200	Micropolis	MC3391W	5	$1739	$1879
9091MB	8.5ms	7200	Micropolis	MC3391WAV	3	$1939	$2079
9100MB	8ms	7200	Quantum	XP39100W	5	$1599	$1739
9100MB	8ms	7200	Fujitsu	M2949W	5	$1579	$1719
9100MB	8ms	7200	Seagate	ST19171W	5	$2149	$2289
9100MB	**8ms**	**10,000**	**Seagate**	**ST19191W**	**5**	**$3999**	**$3739**
23.3GB	**13ms**	**5400**	**Seagate**	**ST423451W**	**9**	**$4079**	**$4279**



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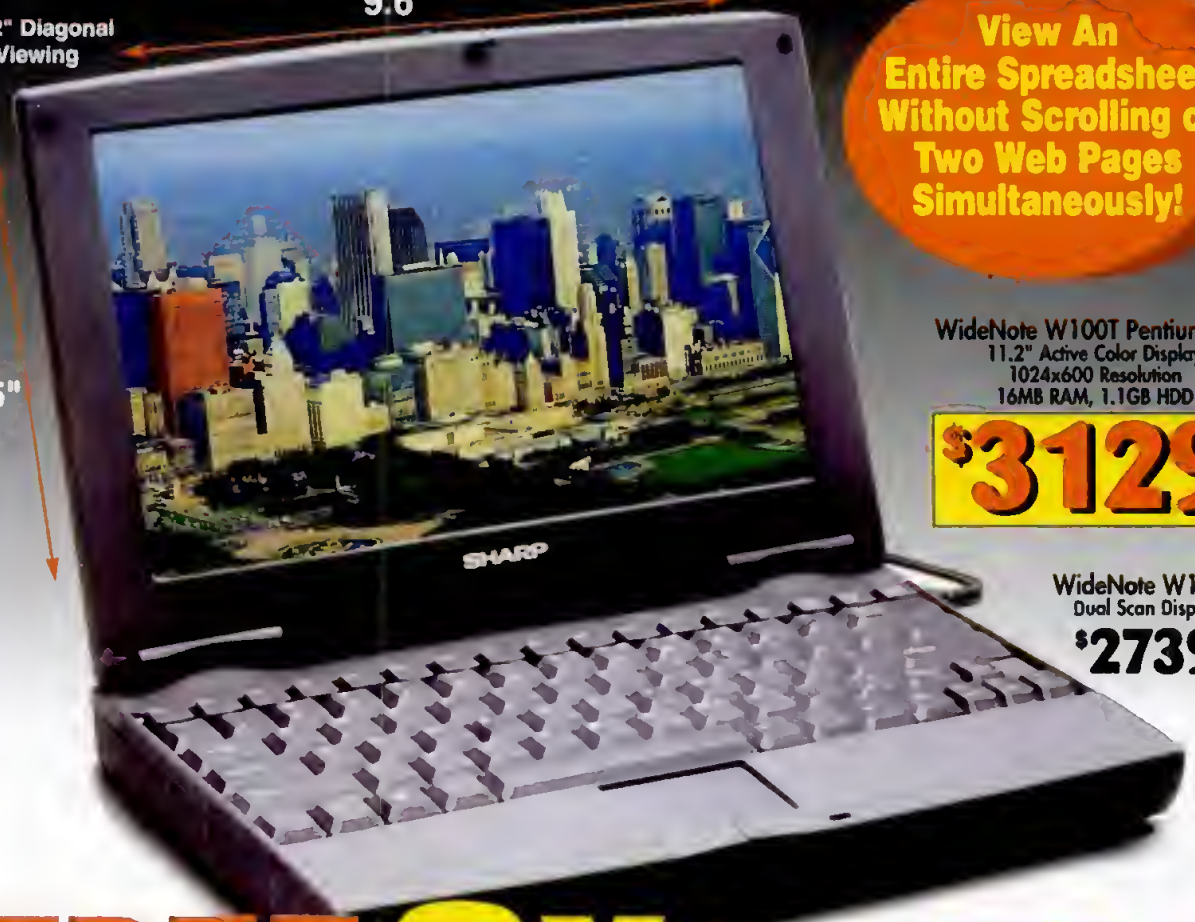
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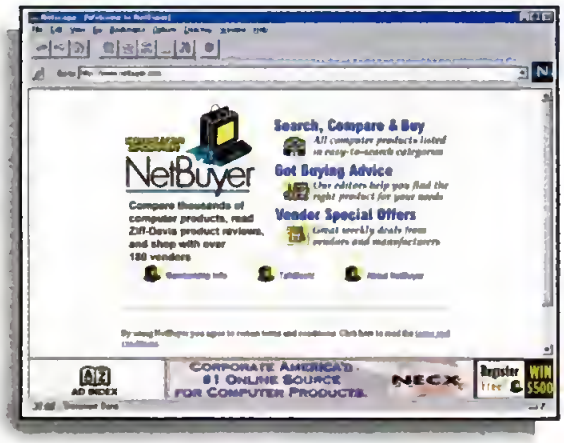
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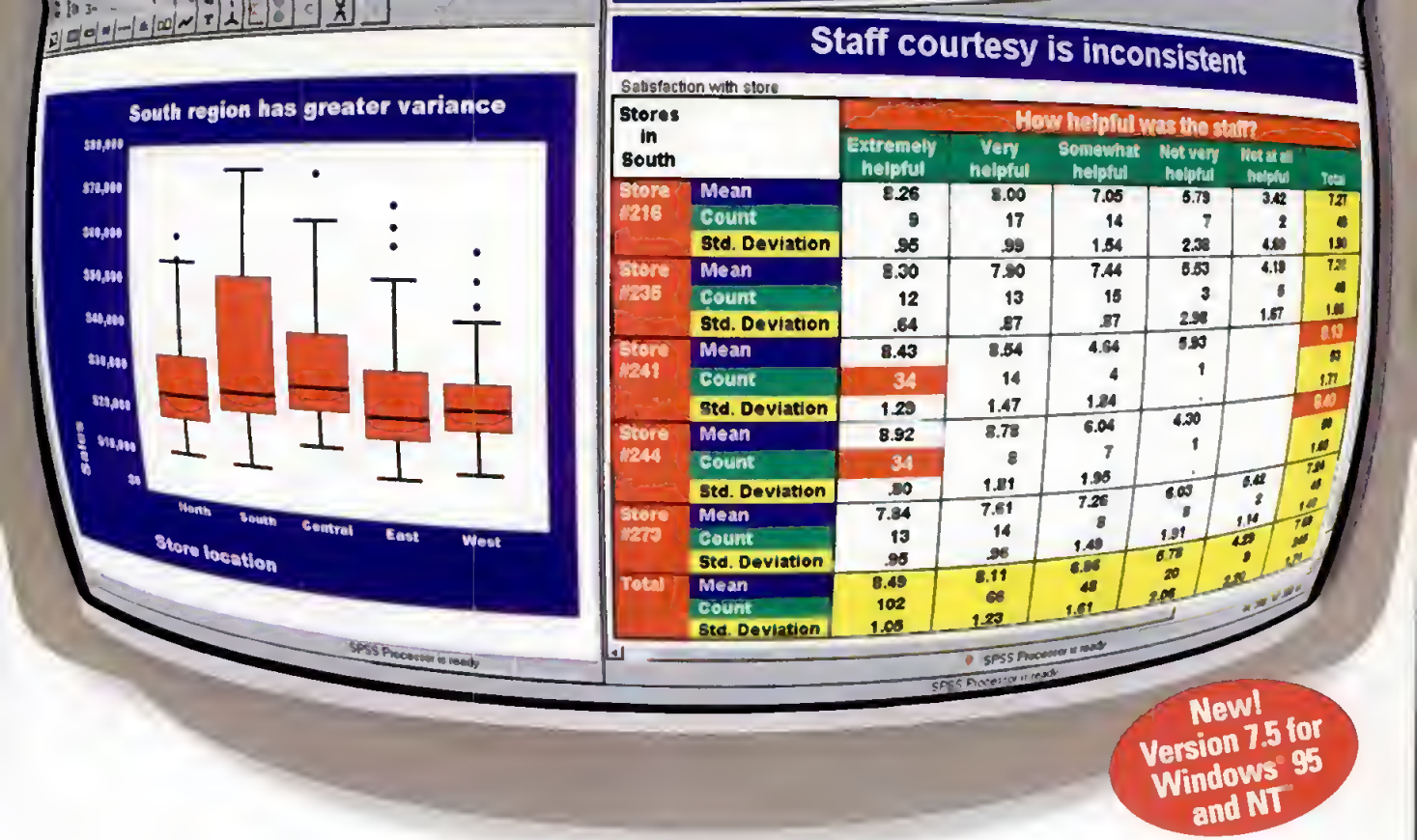
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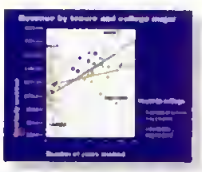
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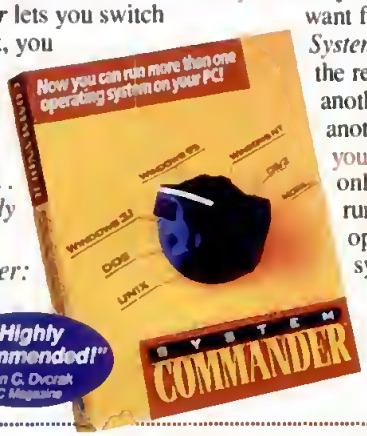
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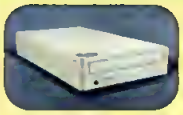
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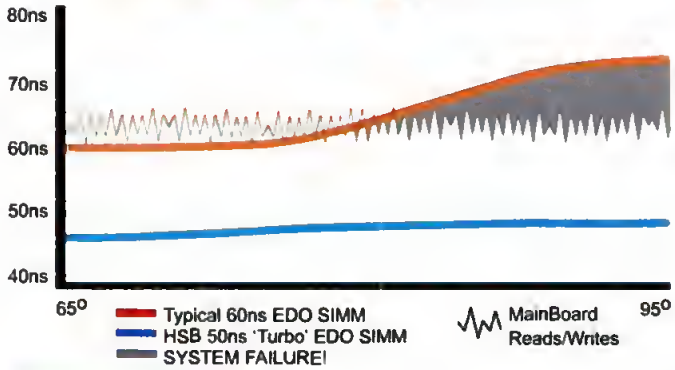
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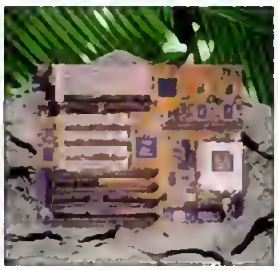
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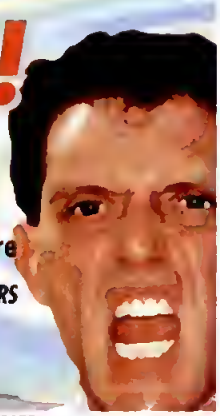
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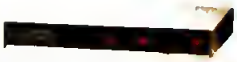
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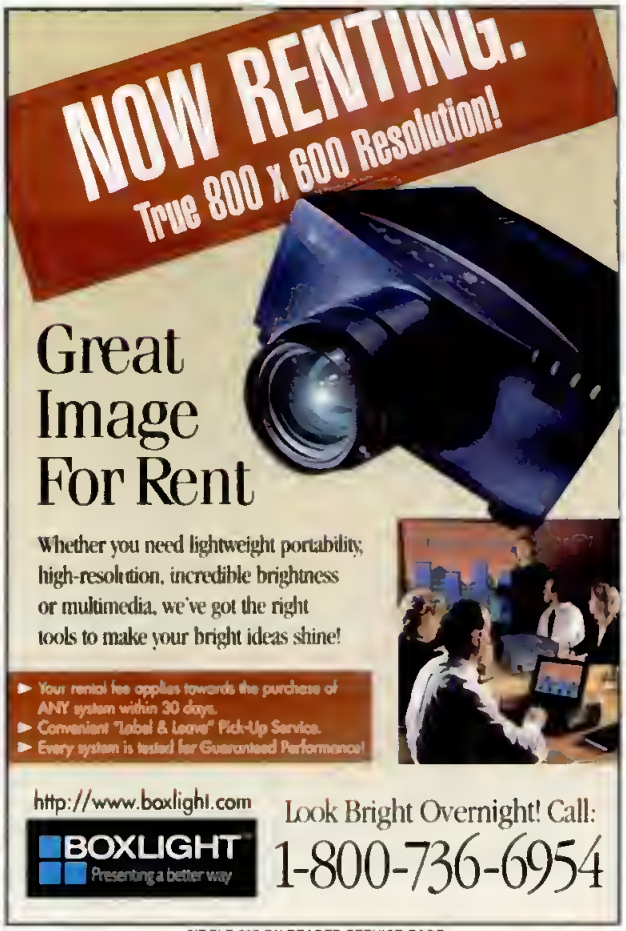
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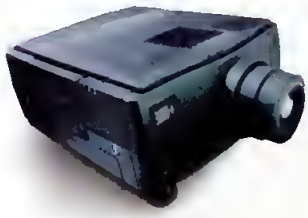
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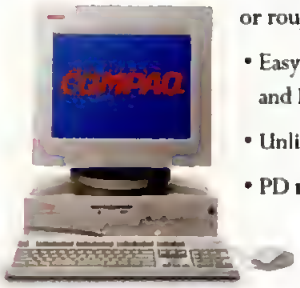
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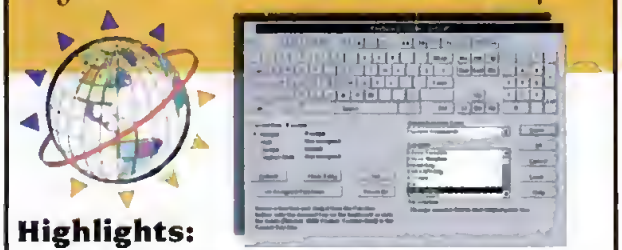
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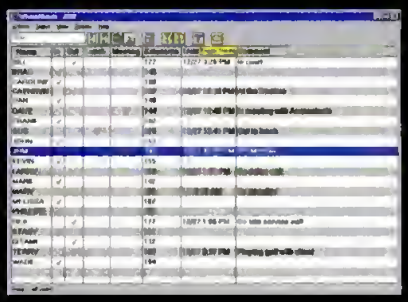
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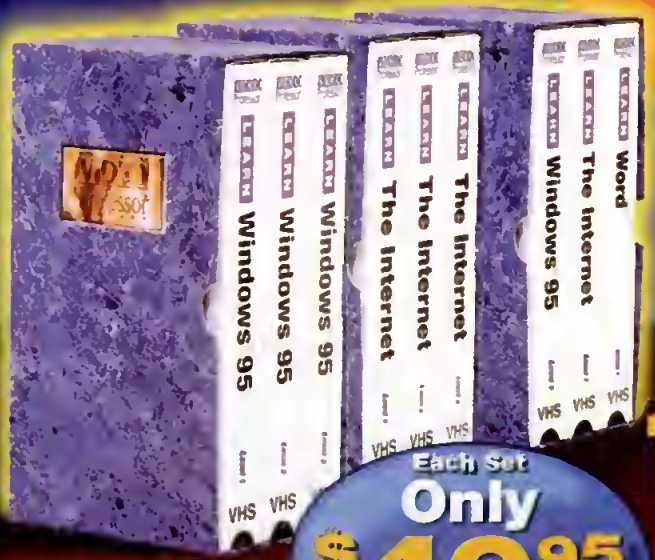
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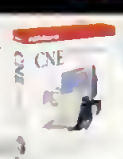
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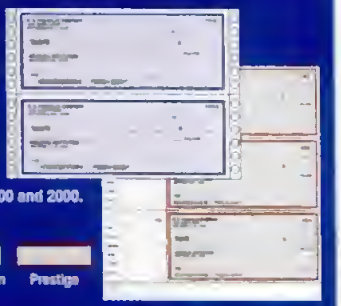
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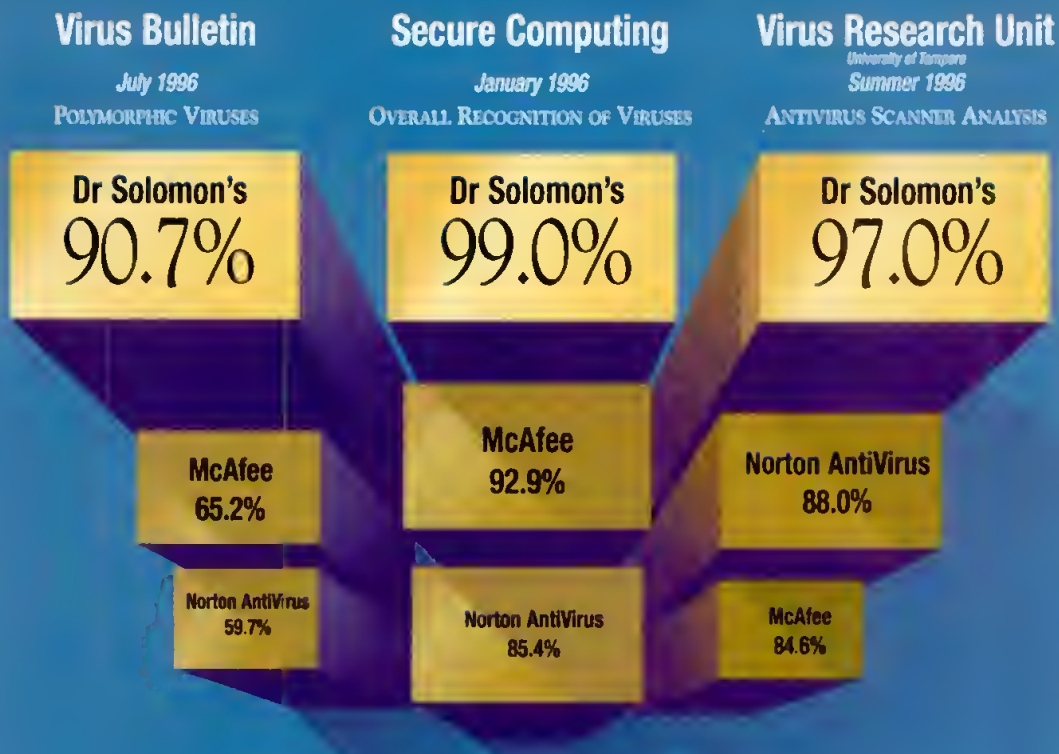
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64MB	—	379.00	499.00

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8MB	47	48
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64MB		429

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1MB	9	10
[illegible]	14	15
4MB	23	23
[illegible]	34	36

EDO

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32MB	149	152

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HP II, IID	68	98			
HP 3SI, 4, 4M, 4SI	48	58	98		
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Panasonic 4410, 4430	84	144			
Panasonic 4420, 4450I	84	144	–	–	
TI Microlaser (1MEG $48)		128			

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256x16 ZIPP Cas	–	39	–
256x16 SOJ EDO	–	–	37
256x8 SOJ	–	19	19

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8Kx8	4	5	6	19
32Kx8	5	6	7	12
32Kx8 (3.3)	–	9	13	
32Kx8 (SOJ)	–	11	15	
64Kx1	7	8	9	
64Kx4	7	8	9	–
16Kx4	5	6	7	–
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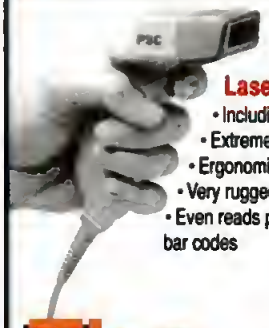


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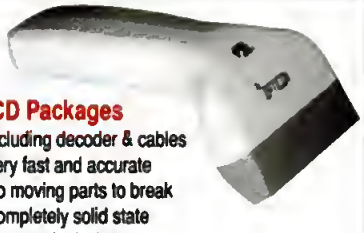
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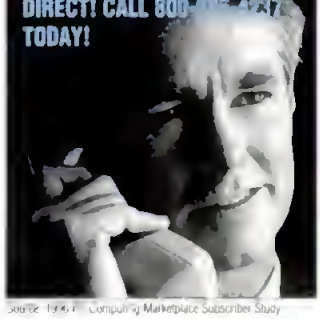
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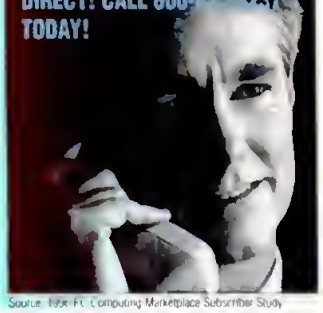
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Diablo

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This is the backdrop for one of the most eagerly anticipated games of the year. Diablo is a phenomenal action game for Windows 95 that offers a dose of role playing, spectacular graphics, excellent multiplayer capabilities, and endless replay value.



DIABLO

Basically, Diablo is a game of hack and slash, with your character doing the majority of both (you hope). You begin the game as either a fighter, mage, or thief, each of which has advantages and disadvantages.

You then enter the town of Tristram. Here you'll find the blacksmith and the healer, for example, but if you explore the town's surroundings you'll find other helpful people. This is a place to rest, get information, and buy weapons, potions, and spells.

Gear in hand, you enter the cathedral. The dungeons below the old church contain monsters and magic, treasure and traps. In all, you'll have to fight your way through more than 15 levels of this labyrinth. And each time you begin a new game, the levels are randomly generated, so no two games are alike.

Diablo revolves around the main quest of defeating the title demon, but along the way you'll learn of other quests—which also change with each new game.

The action is simple: Click your mouse where you want your character to go and he obeys. Any items that you can interact with—such as monsters, doors, barrels, and fountains—will be highlighted. If you click on them, your character will attack, open, break, or use them (whichever is appropriate).

On the first level, Diablo is relatively easy. But as you move deeper into the game, you'll face monsters far more dangerous in far greater numbers. As your character moves through the game, however, he grows more powerful, so by the time you reach the end, you always have a fighting chance to win. (It doesn't hurt to save the game often, though.)

The game's Super VGA graphics are stunning. Your character and the creatures you encounter are fully rendered and animated, as are the many magic spells. The attention to detail in this game is amazing, and it's increasingly noticeable the farther you progress.



DIABLO

Diablo is an outstanding single-player game, but it is even more fun when played with other people. It supports two-player games over modem links, and four-player games over IPX networks or the Internet using Blizzard's free gaming service battle.net. Though the performance over battle.net was occasionally sluggish, we were impressed with the service's slick interface and the cooperative on-line game play.

Combine these factors, and you have one of the most impressive games we've ever seen. If you're looking for the best, most addictive action game around, Diablo is for you.—*Michael E. Ryan*

IN AFTER HOURS

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One by Land, Two by Sea

Two more top-notch strategy games to challenge you—and one to avoid.

Lords Of The Realm II

Ah, medieval times! The damsels in distress, the combat, the pouring of boiling oil on your enemies. Who could ask for more? Before you answer that, you might want to try managing and defending your own little kingdom in the Windows 95 game, Lords Of The Realm II.



In Lords II, you're one of five nobles vying for the crown of merry old England in 1268. Starting with one humble county, you must manage crops, build a castle, and amass an army to defeat your opponents.

The game's turn-based resource management portion is very well designed. The happiness of the general populace is your primary concern, and as in real life, that happiness is affected by taxes, health, and discouraging events such as invasions. You can increase happiness by doubling rations, distributing ale, and keeping taxes low. A happy populace will grow, giving you more people to tax and draft into armies. Be careful, though: Tax too much or draft too many and you'll have an ugly revolt on your hands.

If you like, you can play the entire game in this mode, letting the computer handle all the combat, and still come away very satisfied. But if you prefer to fight your own battles, you'll find the field-combat mode similar in appearance and function to that of Blizzard's Warcraft titles. The combat mode is fun, but it has a few quirks: You don't have many options while commanding individual combatants, and the computer's artificial intelligence is not terribly impressive.

Still, Lords Of The Realm II is a good game with a decent real-time engine and a thoroughly enjoyable, turn-based strategic model, providing all the tools an aspiring monarch needs to claim a throne.—*Shane Mooney*

Age of Sail

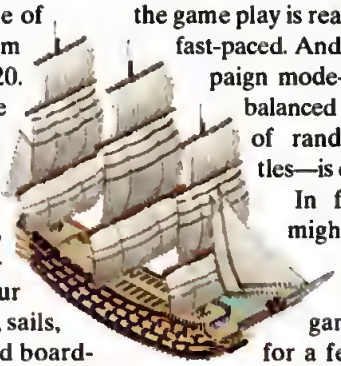
Real time is all the rage these days in strategy gaming, but we've seen few titles that use real-time action to provide a rich gaming experience while at the same time actually enhancing the game's realism. That is, until we saw Age of Sail, the latest effort from TalonSoft.

Age of Sail is a Windows 3.*x* or 95 game of naval combat from 1775 through 1820. You can play single scenarios or embark on a campaign spanning many years. In either case, you control everything for each of your ships: course, speed, sails, firing, reloading, and boarding. While this may at first seem overwhelming in large-scale battles where you command 15 or more ships, we were surprised at how easy it was to learn. (Winning takes a bit of practice, however.)



The game boasts a number of impressive statistics: 100 scenarios (including such massive engagements as Trafalgar and Camperdown), campaign mode for four different countries (England, France, Spain, and the United States), and over 2,000 historically accurate ships. The game also includes a top-notch scenario editor.

But Age of Sail has more to offer than statistics. The Super VGA graphics are stunning, with a staggering attention to detail—right down to the battle damage on each ship. Also, the game play is realistic and fast-paced. And the campaign mode—a well-balanced sequence of random battles—is excellent. In fact, this might even be the perfect game, if not for a few flaws.



The most annoying is that the game's introductory sequence will load before *every* mission—until you disable it from the menu. Also, the computer will occasionally decide that your ship wants to surrender, whether you want to or not. Finally, the game's outstanding music is wasted in large battles: It is recorded in .WAV files and is constantly cut off by the .WAV sound effects.

But none of these significantly detract from the rich experience Age of Sail provides. As far as real-time games are concerned, this is one of the very best.—*MER*

Admiral: Sea Battles

Some games can simplify complex subject matter and get away with it because they are well designed, challenging, and fun. Admiral: Sea Battles attempts to

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[DICTIONARY OF THE FUTURE, PAGE 531]

lost (lôst) *adj.* [archaic] **1.** unable to locate one's position, as in, "Help. I am lost." **2.** having no sense of direction at all **n.b.** became obsolete in 1996 with the introduction of Street Atlas USA 4.0 and Tripmate.

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be one of these titles but fails miserably.

Instead of the ultrarealistic feel of Age of Sail, Admiral gives players a simplified taste of naval combat from the same era. The simple approach is often best, and we had high hopes for Admiral. But when we played this Windows 95 game, we quickly lost heart.



ADMIRAL: SEA BATTLES
★★★★★ $40 street,
Media Corp., 800-634-2633,
www.megamed.com.

Things started out well. Game play in Admiral is straightforward, as you move your ships around a nicely detailed grid. The graphics are decent, and the game's rendered cinematic sequences are pretty nice. And we liked the idea behind the scenarios, which combine sea and land operations.

The problem here is that Admiral's promise was only skin-deep: The first, last, and all other scenarios are ridiculously difficult and not much fun to play. Also, the interface is confusing, and the documentation is sparse at best.

If you're looking for an enjoyable game in this genre, we recommend Age of Sail or Wooden Ships & Iron Men. —*MER*

QUICK CLIPS

Tempest 2000

Remember that frenetic vector-graphics arcade game that made Pac-Man look so mellow? Well, it's back with a slightly new look and a whole slew of new levels. Spin your way around a host of wild arenas as you try to shoot down those evil polygon creatures. Lots of fun—a good alternative to Solitaire, too. $39.95 list; Interplay Productions, 800-468-3775.

Bill Nye the Science Guy: Stop the Rock!

An interactive science adventure that the whole family can enjoy, this CD-ROM (developed by Pacific Interactive) challenges players to prevent a meteoroid from hitting the Earth. Lots of experiments and lots of live-action video footage of the Science Guy himself help make this title interesting and fun. $40 street; Disney Interactive, 800-688-1520.

SoulTrap

Touted as a breakthrough in 3-D gaming, this interesting title is pretty to look at but difficult to control and not very much fun to play. In the age of Quake and Tomb Raider, this one just doesn't measure up. $44.95 list; Microforum, Inc. 800-685-3863.

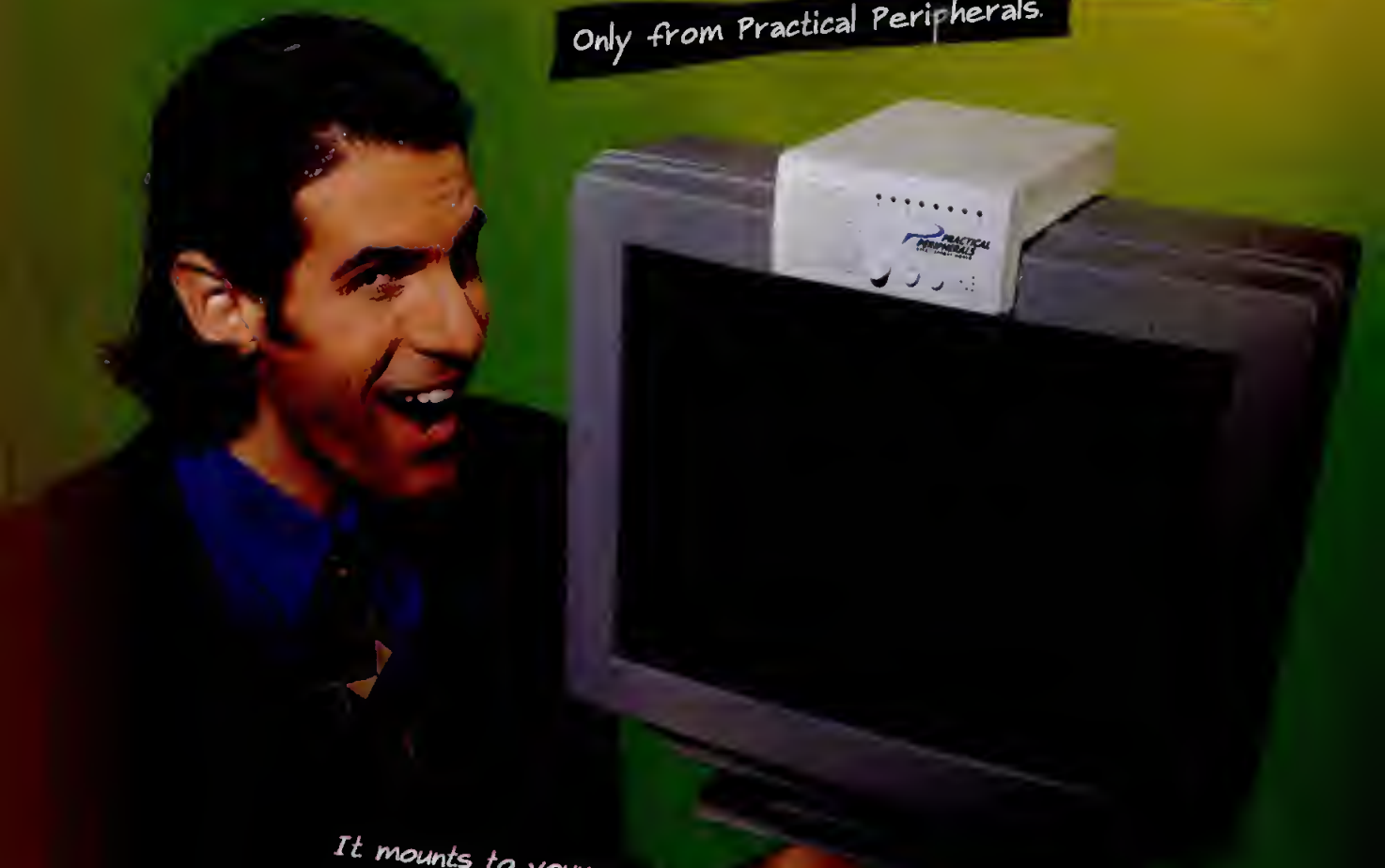
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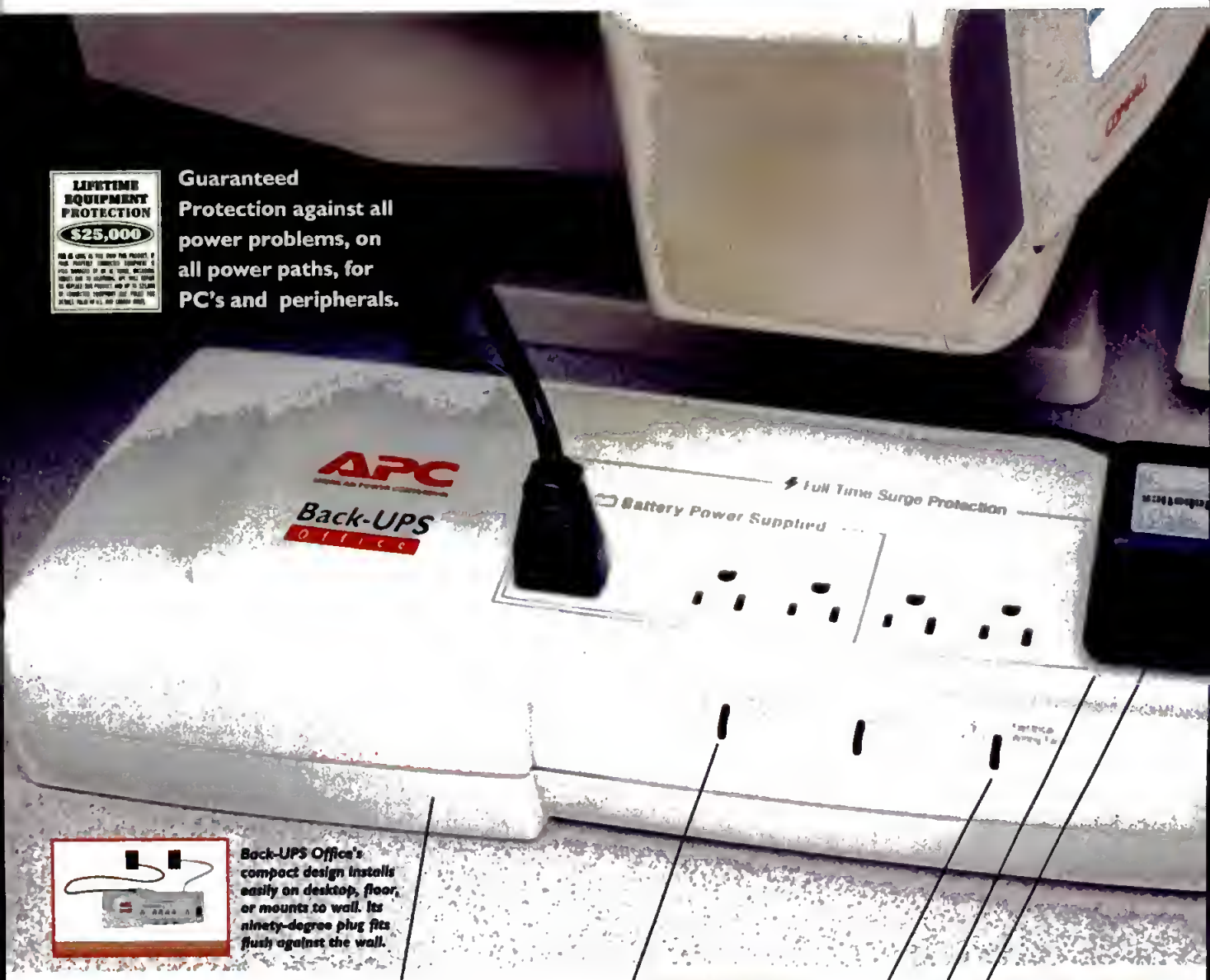
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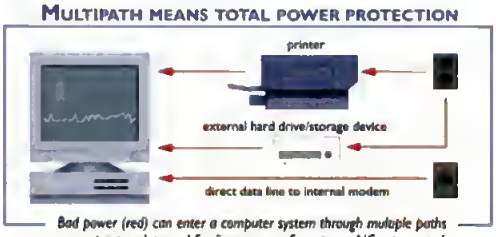
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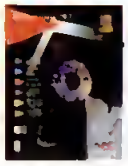
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Barbie Fashion Designer

Barbie Fashion Designer was *the* best-selling software during the 1996 holiday season. And with good reason. One of the first successful software packages designed specifically for girls, the Fashion Designer CD-ROM makes it easy for your budding Donna Karan to become a couturier to her own dolls.

Using this software and a printer, children—with a little help from an adult—can design their own Barbie outfits. Once completed, the ensembles can be printed out on special "sticky-backed" fabric that can be put on a doll and decorated with sequins, paint and appliqués.

The program features a simple interface and perky narration that will get kids designing in no time. Kids are given six clothing themes to choose from: Totally Trendy, Dream Date, Party Surprise, Vacation Fun, Cool Careers, and Wedding Fantasy. Each theme includes several pieces of clothing that children can add to their perfect outfits. Every article of clothing can be personalized, mixed, and matched.

Once your child has decided on an item of clothing and clicked on it, Barbie will sport the apparel. After an outfit is complete, children can further personalize by adding patterns, colors, and accessories.

Even cooler, kids can preview their creations in Barbie's dressing room and watch Barbie saunter down a 3-D runway wearing their designs.

Most children will probably spend the majority of their time coloring, painting, and customizing outfits after they've been printed—and of course dressing their dolls.

Although the program is a great tool for young designers, we have to stress that it *is* just a tool. The real imagination and fun will take place after they turn off the computer. The process of creating a Fashion Designer pattern can take only a few minutes, and once the printer has done its work, your children will probably get distracted by their dolls.

When you run out of fabric paper or the proprietary art supplies, you can restock using Mattel Media's Fashion Designer Refill Kit ($9.99 list), which includes additional designs.—*Karen Bannan*

Time to Trade Some Paint

The most realistic racing game around is back with more options and faster action.

NASCAR Racing 2

NASCAR Racing 2, the latest offering from Papyrus and Sierra On-Line, brings the thrill of championship racing realism to your PC. Like its predecessor, NASCAR 2 is fun, realistic, and challenging.

Jump right into the action with the "quick race" option, select from one of 16 authentic NASCAR racetracks and set such options as weather conditions, race length, and number of opponents. You can also choose between arcade and simulation modes.



NASCAR RACING 2
★★★★☆ $49.95 list. Sierra On-Line, 800-757-7707, www.sierra.com

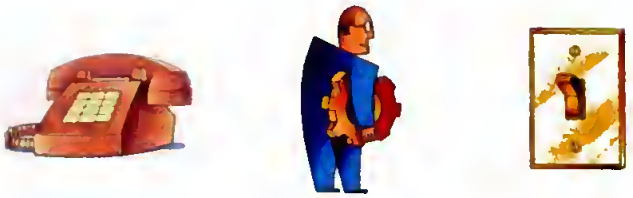
For a full-blown Race Weekend, you first need to go out for a few test laps. Once you see how your car behaves, you can adjust the gear ratio, spoiler angle, tire pressure, and other factors. Then you're ready to qualify for and take part in the big race. You can also enter a Championship Season, a series of races at all 16 tracks.

The game play is smooth and enjoyable. You can choose from three perspectives to see the action: a view from right behind the steering wheel, an overhead view from the rear of the car, or a wide-angle view of the track. There is also a VCR option that lets you view replays from over 300 camera angles. The sound effects include squealing tires and approaching car engines. You also hear your spotter over the radio, relaying your position and those of your opponents.

Aside from the keyboard, NASCAR 2 supports joystick, gamepad, and steering-wheel controls. You can play against the computer, go head to head with a buddy via modem or null-modem cable, or join an eight-player game over an IPX network connection.

Whether you follow the NASCAR racing circuit or just enjoy racing games, NASCAR Racing 2 will provide you with hours of realistic racing entertainment. Go ahead, strap on your helmet and get ready to "trade some paint" with the pros.—*John Delaney*

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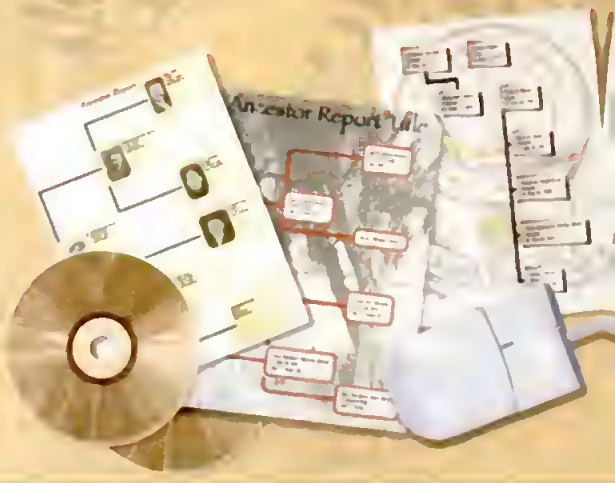
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15 Years of Gaming

Fast CPUs are neat and all, but what review of the PC's history would be complete without a look at the history of games?

By Michael E. Ryan

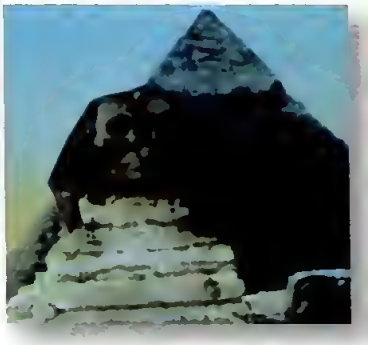
Computer games have come a long way over the past 15 years, marking and helping to further the PC's evolution. Since the early days of strangely addictive text-based adventure games, games have become significantly more impressive in the areas of artificial intelligence, graphic detail, sound effects and music, and of course, minimum system requirements.

The 15 products we've chosen here are some of the most popular and influential titles in PC gaming history.



▲ **Zork** (1982): The definitive fantasy adventure game and the inspiration for countless others, Infocom's text-based Zork captured our imaginations and kept us typing into the wee hours of many a night.

▼ **Where in the World is Carmen Sandiego?** (1985): It was Broderbund's first Carmen Sandiego title that showed us how computer games could be fun, funny, and educational all at once.



Microsoft Flight Simulator (1982): Originally developed by subLogic for the Apple II, Microsoft Flight Simulator helped demonstrate the original PC's graphics capabilities while at the same time spawning legions of devoted flight-simulation enthusiasts around the world.

Wizardry (1984): Although first released for the Apple II in 1981, Sir-Tech's outstanding fantasy role-playing series, Wizardry, finally came to the PC in 1984

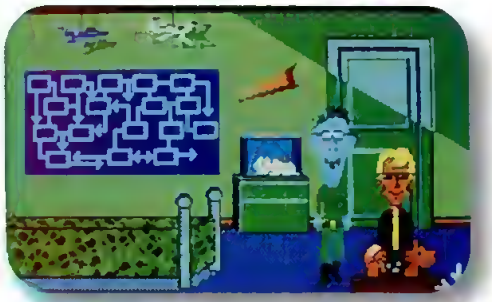


▲ **Ultima** (1986): Origin Systems' Ultima provided us with a fantasy role-playing experience unlike anything we had ever seen before.

King's Quest: Quest for the Crown (1984): Would you believe that IBM commissioned this Sierra On-Line title to show off the hot new PCjr? Thankfully, the game survived its first platform, and this series of graphical adventure games continues to this day.



◀ **Wing Commander** (1990): The reason many of us bought our first VGA cards, Origin Systems' spectacular cinematic space adventure left little doubt among Macintosh and Amiga users: The PC was now the game player's platform of choice.



◀ **Maniac Mansion** (1988): LucasArts made gaming history with Maniac Mansion, the first adventure game to implement a point-and-click interface

▼ **DOOM** (1993): With DOOM, id Software opened the floodgates for first-person action shoot-'em-ups.

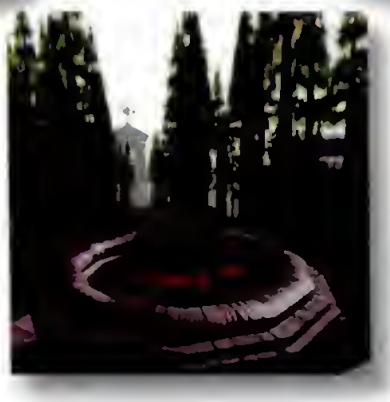


Populous (1989): The quintessential god game, Bullfrog's Populous not only gave you absolute power over a bunch of tiny beings but also marked one of the earliest appearances of real-time strategy gaming.

SimCity (1989): If you build it, you then have to manage it well. Maxis's game of urban development stands up as one of the most enjoyable games ever.

Falcon 3.0 (1991): Spectrum Holobyte's classic jet-combat simulation offered great graphics for its day, realistic flight modeling, dynamic campaign play, and multiplayer support—quite a combination.

Sid Meier's Civilization (1992): Possibly the greatest computer game of all time, MicroProse's strategy masterpiece gave players the opportunity to rule their own kingdoms in any way they saw fit.



◀ **Myst** (1994): The graphic adventure that shook the world. Broderbund's Myst challenged the hard-core game players while helping to open the arcane world of computer gaming to the rest of us.



▲ **Quake** (1996): Just when we thought it was save to go back on the LAN, id Software came back at us with this revolutionary, frenetic shoot-'em-up.

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The Big Utilities Roundup

Don't miss our annual utilities blowout, featuring all kinds of software for helping you get more out of your PC. We've rounded up suspects in the usual categories—and found a bunch of new utilities that will help you make the most of your Internet time. Although Windows 95 still draws the most attention from utility vendors, we also include tools for a few other OSs.

Desktop Tools

The standard-bearer utility categories are still popular, but new product versions are out. We round up antivirus packages, diagnostics tools, performance enhancers, program uninstallers, and file viewers. And we add an extra dollop of miscellaneous tools for all kinds of desktop checking and tweaking.

The Internet and You

We've got you covered for Internet tools. Paying special attention to making your searches more effective, we review off-line utilities, screening packages, and other tools you'll find useful.

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PC Magazine, (ISSN 0888-8507), is published twice a month except in July and August, at $49.97 for one year. Ziff Davis Publishing Company, One Park Ave., New York, NY 10016-5802. Periodicals postage paid at New York, NY 10016-5802 and at additional mailing offices. POSTMASTER: Address changes to *PC Magazine* P.O. Box 54093, Boulder, CO 80328-4093. The Canadian GST registration number is 14049 6720 RT. Printed in the U.S.A.

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NE—Network Edition

For information about the Network Edition of *PC Magazine*, call Circulation at 800-289-0429

Abort, Retry, Fail?

FIFTEEN YEARS ON THE LIGHTER SIDE

By Don Willmott



March 1982

Powerful prophecy: "Perhaps expecting that IBM won't satisfy the demand of all who want to buy—or sell—IBM PCs, at least three companies are said to be preparing 'lookalikes.'"

Price/performance: "Expand your PC's memory to 256K with one slot for $1,095."

Hard-hitting review: "The IBM packing boxes *look* good—a tasteful gray-and-white extension of the highly stylized machinery within."

Exciting development: "There are 300MB disks down in the $10,000 to $15,000 range now."—*Bill Gates*



26-year-old Bill Gates lays down the law.



March 19, 1985

Sad lament: "I wish they'd let me have an AT, but there aren't enough ATs to go around."—*IBM VP Bob Markell*

Online advances: "You can now call the *PC Magazine* Interactive Reader System. We're starting small, with just one incoming phone line."—*Bill Machrone*

Chunky clunky: "The Visual Commuter Computer [weighs] in at 21 pounds, with two floppy disk drives and an LCD display."

Bold prediction: "The days when writers can hand in stories and articles on paper may soon be numbered."



In the early days, *PC Magazine*'s illustrations had real people in them.



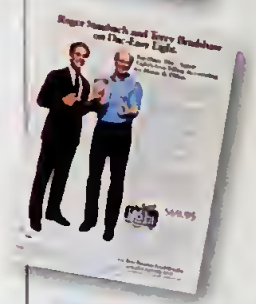
March 15, 1988

Top five software sellers: Lotus 1-2-3 2.01, WordPerfect 4.2, Microsoft Windows 2.03, Varsity Scripsit, dBASE III Plus.

Dust to dust: "Lotus. . .likes to point out that if Symphony were a software publisher's only product, that company would rank among the top ten firms in the business."

Speedy: "Get your hands on an ALR FlexCache, [a] new 20-MHz 80386-based screamer that leaves IBM's PS/2 Model 80-111 catching its breath." Price: $7,495.

Right, right, wrong: "Floppy disks are getting smaller—from 8-inch to 5.25-inch to 3.5-inch and probably down to 2.5-inch."—*John C. Dvorak*



Roger Staubach and Terry Bradshaw shill for accounting software. Touchdown!



March 12, 1991

Still waiting: "In time, many Windows applications will add the ability to accept handwriting directly, and eventually programs will be designed to make the most of the pen."

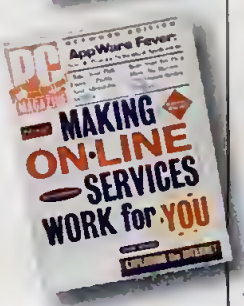
Right at the time: "Settling on the right microprocessor is obviously a key issue here. . . . My recommendation has been to buy 386SXs."—*Jim Seymour*

Lingering death: "The people have spoken. They just don't want OS/2 on their desktops."—*Bill Machrone*

And we loved them: "By the middle of 1991, you should see notebook computers with 40MB hard disks, and in the second half, you should start to see notebooks based on Intel's low-power 386SL integrated chip set."



PC Magazine's top-sellers chart. We didn't understand it either



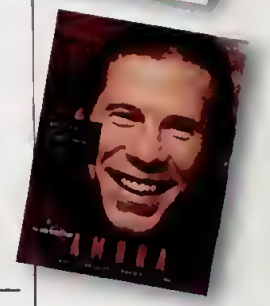
March 15, 1994

Chip wars forever: "If Apple can make the [PowerPC] chip emulate the Motorola 68000, then others can make it emulate the Pentium. When that happens, look for a lawsuit."—*John C. Dvorak*

The Interwhat? "Although software designed for searching the Internet has become easier to use and more sophisticated recently, it still has a long way to go."

Three years later, still testing: "Hoping to leverage the 60 million cable-subscribing households across the country, online services have started to field-test prototype cable modems."

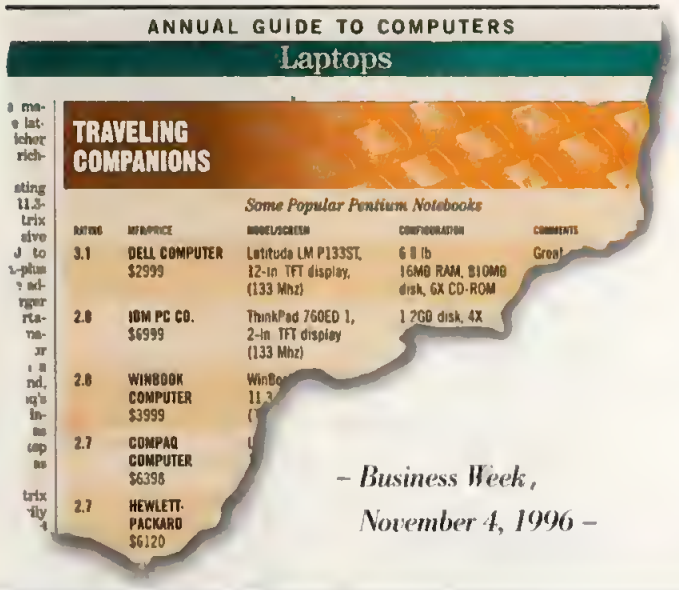
Wait and see: "How well the Internet adapts to this explosion of interest will likely determine if it can indeed act as an on-ramp to the national data highway."



Betcha he's a lot less psyched about Ambra today.

If your entry is used, we'll send you $50 and a *PC Magazine* T-shirt. Send your entries to Abort, Retry, Fail?, *PC Magazine*, One Park Ave., New York, NY 10016-5802 or, via e-mail (text items only), to *don_willmott@zd.com*.

CAN YOU REALLY AFFORD TO BUY THE #2 NOTEBOOK?



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Some Popular Pentium Notebooks

RATING	MFR/PRICE	MODEL/SCREEN	CONFIGURATION	COMMENTS
3.1	DELL COMPUTER $2999	Latitude LM P133ST, 12-in TFT display, (133 Mhz)	6.8 lb 16MB RAM, 810MB disk, 6X CD-ROM	Great
2.8	IBM PC CO. $6999	ThinkPad 760ED 1, 2-in TFT display (133 Mhz)	1.2GB disk, 4X	
2.8	WINBOOK COMPUTER $3999	WinBo... 11.3 (T...		
2.7	COMPAQ COMPUTER $6398	L...		
2.7	HEWLETT-PACKARD $6120			

– *Business Week*, *November 4, 1996* –

What's wrong with this picture? The notebook that gives you the most performance, usability and features costs half the price of notebooks that give you less. (Notebooks, by the way, that you probably thought gave you more.) And remember, you have this information on the very best authority. *Business Week*, the business publication, in their Second Annual Computer Buying Guide cited the Dell Latitude LM P133ST as "the top ranked machine in the tests" and the notebook they'd most like to travel with. So if you're shopping for a notebook, buy the best. After all, you can afford it.



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